GUIDE TO
HIGHER AQUARIUM ANIMALS

EDWARD T. BOARDMAN

CRANBROOK INSTITUTE OF SCIENCE

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Foreword

This little book is a companion to the author's *Field Guide to Lower Aquarium Animals*, in which invertebrate animals of the Michigan area are figured and described. Doctor Boardman, at this writing overseas as a First Lieutenant in the United States Army Sanitary Corps, was granted leave of absence for military service before many of the illustrations had been selected and before his manuscript was ready for the compositor. In consequence, he should not be held responsible for such errors as may have crept into the finished book.

We wish to give special acknowledgment and thanks to those persons and institutions furnishing illustrations for the book without remuneration to themselves. These are:

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Dr. A. H. Wright

—*The Editors*

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Illustrations

The person or institution supplying each illustration is named following the caption.

Guide to Higher Aquarium Animals

By Edward T. Boardman
Zoologist, Cranbrook Institute of Science

Introduction

This book is intended for amateur naturalists and teachers as a guide to selected vertebrate animals suited to aquarium life. In general I have tried to indicate which animals can be found readily, which will do well in captivity, what food they will need, and what breeding habits or other behavior the reader may expect to observe. Though focused on the Michigan fauna, the guide is intended to be of general use. Obviously, because it is selective it cannot be used as a means to the identification of all vertebrates in Michigan. Reference is made to other books suited to such purposes.

In fairness, I should point out that an aquarium is but a poor substitute for natural conditions. To grow things of any sort requires what the gardeners call a "green thumb," which consists essentially of giving them frequent observation, of being able to profit by experience, and of having an interest which will survive many discouraging accidents.

A good field knowledge of the animals that are to be kept is especially important. For instance, a person who knows from field

experience that a Snapping Turtle will eat only submerged food will know better than to try to feed one in half an inch or so of water. Further, complete knowledge of an animal will assure the owner of making useful observations of the animal in captivity. Another instance: If Mudpuppies or Red-backed Salamanders were to deposit spermatophores, or otherwise breed in captivity, careful notes should be kept and published, for little is known about the reproduction process in these species.

In general, I recommend that aquaria be stocked in September and the inhabitants released by the following June. Few aquaria receive adequate care in summer.

I have often had to make an arbitrary decision as to which animals are aquatic. In certain areas some forms not included in the guide may be decidedly aquatic, while some forms included here may be found to stay on dry land. My excuse must be that nature has failed to provide sufficient distinction between terrestrial and aquatic animals in these groups.

The guide contains little or no mention of where to obtain the invertebrate food animals eaten by the forms discussed. That subject has been covered in some detail in my companion volume, *A Field Guide to the Lower Aquarium Animals.*

The Aquarium

An aquarium can be a beautiful and interesting addition to a room. If properly planned, no other combination of living things occupies so little space, requires so little care, and is so consistently attractive. To attain this ideal condition certain rules must be followed.

AQUARIUM SIZE

An aquarium for vertebrate animals should have a capacity of not less than 10 gallons. My favorite size is one 30 inches long, 15 inches wide and 15 inches high. It holds approximately 30 gallons of water (231 cubic inches to the gallon). I cannot adequately explain the success experienced with this size but it seems to have the ideal surface area to depth ratio. Appreciably deeper tanks seem to hold near the bottom a layer of stale water that adversely affects both plants and animals. Appreciably smaller tanks lack volume and are subject to great fluctuations in temperature.

AQUARIUM LOCATION

The aquarium should be located where it gets abundant light, preferably from the top. There should not be more than one or two hours of direct sunlight. An east or west exposure is good. If the spring light is so intense as to produce an abundance of

algae, shield the window side of the tank with green cloth, green tinted cellophane, or transparent varnish.

Draughts or other causes of sudden temperature changes should be avoided. For that reason set the tank back from the window, if possible, with a radiator between. Where the room thermostats are set for low evening and week-end temperatures the aquarium should be equipped with a suitable heater and thermostat. A 60-watt heater will heat a 30-gallon aquarium.

AQUARIUM SUPPLIES

These supplies can be obtained in nature. Certain native plants, stones covered with the moss *Fontinalis,* and various assorted stones and medium coarse sand can be found outdoors. However, if you are in a hurry it is best to get these accessories in a pet store. In fact, as a general rule the plants *Vallisneria, Sagittaria* and *Elodea* do best if they are aquarium grown. Incidentally, they are the most important oxygenators of the aquarium and are also distinctly ornamental.

Other incidentals include a five-foot piece of rubber tubing for siphoning off the sediment, a razor-blade holder for scraping algae off the glass, and—very important—a glass float ring to prevent food from floating away from the customary feeding place. Most important, do not fail to have a glass lid.

AQUARIUM PLANTING

The sand should be from ¾ to 1½ inches deep on the bottom of the tank, and preferably shallowest near the front. Thus the sediment collects at the front where it will be noticed and can be readily siphoned off.

The following plan of planting a tank designed for such aquatic animals as fish, tadpoles and newts must be modified if adult reptiles and amphibia of many sorts are to be kept, by filling about one-half of the bottom area with rocks and moss to a height above the water level.

Plant *Vallisneria* and *Sagittaria* in the back corners of the tank, carrying the planting forward and toward the middle very spar-

ingly. Somewhere near the middle of the back of the tank place a clump of these plants or of *Elodea*. About 200 to 300 *Vallisneria* and *Sagittaria* plants and one bunch of *Elodea* will be needed for a 30-gallon tank. Fewer can be used if you plan to put in a minimum number of fish.

When planting, push the roots below the sand and drag each plant a few inches to its final site. After about ten days tug on the first two kinds until the fibrous roots begin to show. (Otherwise, the leaves will become distorted or die.) Do not be discouraged if your first attempts at aquascaping are not perfect. The growing plants will cover many of your faults.

Never forget that the oxygen-yielding quality of flourishing aquarium plants is essential to the health of your animals.

Aquarium-hardy Michigan Fishes

THE LAMPREYS
(Petromyzonidae)

Lampreys are brown, scaleless, eel-like fishes without paired fins and with circular, sucking mouths armed with rasping teeth. All but a few of the brook lampreys are parasitic upon other fishes at one stage in their life history. When sexual maturity is reached these lampreys stop eating. Eggs and sperm are developed at the expense of the organs of digestion, which almost totally disappear. This development takes place in the fall, but spawning takes place in the following spring, in the swift water of streams. Spawning is a communal affair. Several individuals carry stones from gravel beds to make a nest. After spawning the adults invariably die. They are replaced by little blind, toothless larvae, with horseshoe-shaped mouths, which hatch from the eggs, burrow into the mud of the stream bottom and live there like worms for at least three years before they transform into adults, to complete the life cycle.

American Brook Lamprey
(Entosphenus lamottenii)

Appearance. Adults: mottled blackish and chestnut brown, scaleless, eel-like, with a circular mouth armed with rasping teeth. Larvae: dark brown, wormlike, with a small tail fin.

Size. Adults: 150-250 mm. long. Larvae: from about 3 mm. to adult length.

Habitat. Chiefly in broad, shallow brooks and streams, the adults in crevices under stones or debris, the larvae in submerged banks of silt.

Breeding Habits. The eggs are laid in communal beds by several pairs. These basin-shaped depressions are formed above the riffles by the lampreys' pulling stones away from the center of the site and depositing them around the edge, especially downstream. The spawning female attaches herself to a large stone by means of her sucking mouth. The male attaches himself to her head in the same manner. Their tails are curved downward into the sand and vibrated as the sticky, white eggs are deposited. The eggs adhere to particles of sand and gravel.

Food. The adults do not feed. The larvae eat the algal incrustations from stones and water plants, as well as the living ooze from the pond or aquarium bottom. They feed chiefly at night.

Adults seined from a stream in the fall will survive through the winter unless they spawn. If spawning takes place lampreys die. The larval lampreys often can be obtained by digging or raking in sand or mud banks downstream from the spawning riffles. The older lampreys can be found farther downstream. They require well-aerated water and a well-established and balanced tank placed where the sun will stimulate the growth of algae.

The American Brook Lamprey (*Entosphenus lamottenii*), one of the commoner species, never grows to be more than 150-250 mm. long. Adults seined from a stream in the fall should survive during the winter, but will not feed. Larvae can be obtained in some sites from the mixed sand and mud of the stream bottom at any time of the year. They require well-aerated water and a silt bottom containing bacteria. At no stage is this species parasitic on other fishes.

A well-established aquarium should be used for lampreys. Preferably, it should be in a well-lighted position so that it will have incrustations of algae on the glass and stones. The larval animals will emerge to feed upon these incrustations at night.

THE GARPIKES
(Lepisosteidae)

Garpikes are long, rather cylindrical fishes with beaklike jaws and bodies covered by such a tough armor of scales that the Carib Indians used gar skins for breastplates. Gars are related to some of the earliest fossil fishes, as is shown by the continuation of the vertebrae along part of the upper margin of the fan-shaped tail. They are fierce predators and in some localities seem bent upon destroying all other fishes of less ancient lineage. Man, the most zealous predator, is their only successful enemy.

Longnose Gar; Billfish
(Lepisosteus osseus)

Appearance. Body long, slender, pale olive above, silvery below, the body and posterior fins with black spots. There is a black band along the side of the young fish which is also distinguished by a lance-shaped upper lobe to the tail fin. This lobe later disappears.

Size. 1500 mm. long.

Habitat. Lakes and rivers, where they are sometimes locally abundant.

Breeding Habits. During late May and early June the adults work their way into the grass and water plants of shallow water to spawn.

Food. Mosquito larvae and daphnia can be given to the very young fishes. Minnows of suitable size are best for somewhat older fishes, but they will learn to eat chipped liver or fish.

The Billfish is interesting to keep because of its form and habits.

Even young fish live alone. As a Billfish 50 mm. long may contain fifteen or so tiny minnows it is no wonder that no gar will trust his brother. The habit of this species of basking motionless near the surface of some shallow bay apparently is as deceptive to other fishes as to man, for it can move at great speed and shows wolf-like ferocity when it sights its prey.

During warm weather a gar frequently comes to the surface to stick out its bill in order to renew the air in its swim bladder. This act is accompanied by an audible snapping of the bill. During cold weather this habit is discontinued.

Shortnose Gar *(Lepisosteus productus)*

Appearance. Body long, slender, greenish above, white below, the back fins spotted with black. The beak is almost one-seventh the total length.

Size. 600-900 mm. long.

Habitat. Lakes of the two southern tiers of counties in Michigan.

Breeding Habits. This species, too, spawns in weedy shallows in June.

Food. Any animal it can swallow, especially fishes.

The habits of this species are much like those of the Longnose Gar, and it is quite voracious.

THE BOWFINS
(Amiidae)

The bowfins are cylindrical fishes with bulldog heads and stubby tails. They have a dark spot near the top of the tail base which is especially conspicuous in the males and serves as a mark of identification. The vertebrae run part way along the top margin of the tail. The dorsal fin runs almost the entire length of the body. Like the species of the preceding family, they are living fossils, most of whose relatives adorn ancient fossil beds. They feed on crayfish and fish, chiefly at night.

Dogfish; Bowfin
(Amia calva)

Appearance. Bulldog-headed fish which taper but slightly to their stubby tails, the body covered by small scales. Adults: dark olive above, yellowish beneath, with a dark spot near the top of the tail. Young: apple green above with three dark brown bars on the face; the gill cover and dorsal, anal and tail fins all have a dark margin with an inner rose-pink stripe; a brown stripe within the pink on the dorsal, anal and tail fins; the brown spot on the tail is ringed with pink. Like the gar pikes, the young hatch with lance-like tails, beneath which the permanent tail fin develops.

Size. 450-600 mm. in length.

Habitat. Chiefly wooded lakes and rivers.

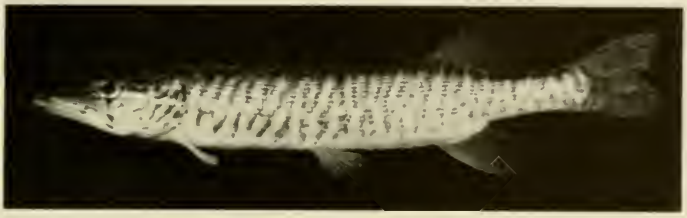
Breeding Habits. In June or July the male selects a nesting site in some weedy bay containing stumps and logs. There, working chiefly at night, he rubs or bites off the vegetation and fans away the loose debris with fins and tail until a bed of sand or rootlets is exposed. The female spawns in the nest at night. The eggs hatch in about ten days, after which the young attach themselves by means of an adhesive organ on the nose, or lie in the nest. The nest, and for a time the swimming young, are guarded by the male. When about 100 mm. long the young are forced to fend for themselves.

Food. Living aquatic insects, crustaceans, worms, snails, fish, raw meat, etc.

Only the young are suitable for the aquarium, and even they should not be placed with other fish, unless the other fish are intended to serve as food. Although preferring well-aerated water, these fish are very hardy under all conditions once they have become accustomed to aquarium conditions.

THE PIKES
(Esocidae)

The pikes are almost too well known to require description. They are slender fish whose heads are pointed in front and whose large fins—the dorsal, anal and tail fins—are bunched together at the rear. (The Pikeperch or Walleyed Pike is not a true pike, but belongs to the perch family and has a long dorsal fin which is spiny in front.) The mouth opens half the length of the head. It is well armed with teeth, even the tongue having a band of them.



Mud Pickerel *(Esox vermiculatus)*

Appearance. A small but typical pike. It is grassy green in color, with irregular dark spots and bars. A yellow line runs along the middle of the back. The long, bill-like head is olive green with light patches. The gill covers are bright green and the belly is white.

Size. Probably never more than 350 mm.

Habitat. The reedy shallows of overgrown, mud-bottomed streams and lakes and the shallows of the Great Lakes.

Breeding Habits. Spawning takes place in the overgrown shallows in March. The eggs and young receive no parental care.

Food. Anything that moves. Minnows and aquatic insects are preferred, but a pickerel will soon learn to eat bits of liver.

Because of its ferocity and odd shape this species makes an interesting pet. However, only small specimens should be kept, and even they will swallow fishes of about their own size.

THE KILLIFISHES
(Cyprinodontidae)

The killifishes are small fishes that generally feed near the surface. As a special adaptation their mouths are at the forward part of the head and directed upward. Their heads are broad and flattened, their bodies slender. Our species live in ponds, swamps and sluggish streams, and in bays of the Great Lakes.

Western Banded Killifish
(Fundulus diaphanus menona)

Appearance. A slender minnowlike fish with the typical mouth opening at the top of the head. It is a pale, washed-out olive green along the back, and along the silver sides there are fifteen or more vertical dark olive bars. The belly is white. The bars along the sides of the male may be wider than the silvery spaces between; the gill covers are emerald green. The bodies of breeding males are sprinkled with dark spots.

Size. Adult length, 72 mm.

Habitat. Among the rushes and grasses of clean, sand-bottomed shallows of the Great Lakes and tributary waters.

Breeding Habits. The eggs are deposited along the vegetation in shallow water and are seemingly unwatched.

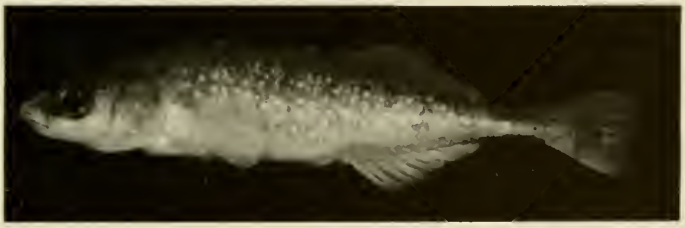
Food. Insects, small crustaceans, snails, small seeds and algae.

Although rather colorless, the Western Banded Killifish is a good aquarium fish. It is hardy and gets along well with other fishes of its size.

THE STICKLEBACKS
(Gasterosteidae)

The sticklebacks are very small, very spiny, exceedingly pugnacious fishes without true scales. The body tapers sharply to a narrow base at the tail fin. Several isolated spines precede the dorsal fin. Each ventral fin is armed with a single sharp spine.

In general, the sticklebacks inhabit the coastal waters and rivers of this country, but certain species are found in fresh waters remote from the oceans. All of them build enclosed nests of sticks and other bits of vegetation cemented together by the males. Each male drives several successive concubines through his nest and then cares for the numerous offspring until they become too large to keep in the nest.



BROOK STICKLEBACK *(Eucalia inconstans)*

Appearance. A tiny, spindle-shaped, scaleless, somewhat compressed fish with prominent spines. There are five large, separate spines which represent the anterior dorsal fin; there is a short, sharp, toothed spine on each pelvic fin, and before the anal fin is a prominent spine only slightly shorter than the fin rays. A sort of bony keel runs from the pelvic fins to the anal fin. The body color is olive overlaid by a network of darker lines in irregular, zigzag patterns. There may be a streak of green at the top of the cheek and gill cover. The belly is pale creamy white. The breeding male is very dark and without an evident color pattern above. Below, it

is bright yellow. The dorsal, anal and tail fins are smoky green. The other fins are pale and faintly white.

Size. Not more than 65 mm. long.

Habitat. Chiefly clear lakes and brooks.

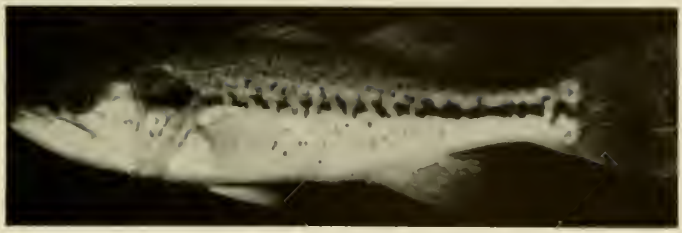
Breeding Habits. The male builds a nest consisting of bits of twig or similar plant material cemented together to form a tiny, ball-shaped nest, about 17 mm. in diameter, with a hole in each side. The nest is attached to aquatic plants and placed so that the current will flow through the openings. The cementing threads are a secretion from the kidneys of the male, resembling the mucin of land snails. The nest is hard to see, even in an aquarium. The male drives successive mates into the nest to deposit their eggs, which he then fertilizes. He guards the nest, eggs and spawn until the young get hopelessly out of control and will no longer stay in the nest. Fishes many times his size fear him, and rightly, for when he has a nest he will kill other fish sharing the aquarium with him —even his erstwhile mates.

Food. Insect larvae, crustaceans, algae and chopped earthworms. Living food is almost a necessity.

There can hardly be a more interesting aquarium fish. However, since it is a stream fish and because of its pugnacity, only a few of them should be placed in an aquarium of 30- or 40-gallon capacity, in April or May. The aquarium should be well planted and aerated and the fish should be fed all the living food they will eat. If a nest is completed, all fish other than the guardian male should be removed if possible.

THE SUNFISHES
(Centrarchidae)

This family, which includes the basses and other sunfish relatives, is quite well known because its members are taken in large numbers by sportsmen. In general, they are deep-bodied, flattened fishes, with a long anal fin and large dorsal fins joined together. The pelvic fins are well forward, near the pectorals. Their mouths are well developed and occasionally quite large.



Largemouth Bass *(Huro salmoides)*

Appearance. The shape of this species hardly requires description, except to state that the mouth, unlike that of the Smallmouth Bass of clearer and colder waters, opens to back of a line drawn vertically from the center of the eye. The Largemouth Bass also has a sage green stripe running from the nose through the eye to the center of the base of the tail. The back is sage green to pale olive. A young fish of aquarium size is pale olive green, sometimes almost a greenish straw color above the stripe, and greenish white beneath. The second dorsal fin is both longer and higher than the first and is separated from it by a deep notch. Older fish tend to be dark green above and greenish white below.

Size. Up to 450 mm. or more in length.

Breeding Habits. A male will fan the silt away from over the sand bottom until he has exposed fibrous plant rootlets. Over this saucer-shaped nest he then drives any female that appears. She deposits eggs and leaves to return again later. The male fans silt away from the eggs and drives off predators until the young fry are too active to be kept together. Spawning takes place in May and June. Often nests will be only a yard or two apart.

Food. Fishes, crawfishes and occasional insects. Lean beef, liver, chopped clam, snails and prepared fish foods prove acceptable in an aquarium.

The young bass tames readily and will break water to catch flies or bits of meat from the hand. It is one of the most hardy of aquarium fishes. When large it will swallow other fish half its size.

BLUEGILL *(Lepomis macrochirus macrochirus)*

Appearance. A short, compressed, deep-bodied fish. The adult is dark olive above. It has six more or less distinct blue-green, vertical bars on the sides. The lower part of the head is bluish; hence the name Bluegill. The cheeks and gill covers are golden olive except for the fleshy flap at the back of the gill cover, which is blue-black. The belly is bright yellow or yellow-brown, darkest near the gills. The fins are smoky green. The dorsal fin, which is made up of the jointed first and second dorsal fins, has a blackish spot at the back. The dorsal spines and those of the anal fin are very strong and sharp. The young fish is pale olive above, with a strong sheen of lavender. It is more slender than the adult.

Size. Adult length about 200 mm., but crowding and other factors frequently dwarf this species. However, where food is abundant the length may be considerably greater.

Habitat. Chiefly lakes and ponds, but it also frequents river bays.

Breeding Habits. Similar to the Largemouth Bass, except that the nests are often only a few feet apart and there may be dozens in a breeding area. Spawning occurs in June.

Food. Aquatic insect larvae, snails, crustacea and considerable vegetable material. I feed this fish canned dog food, or half and half of dried shrimp and rolled oats. It will eat more than it can properly digest, if fed generously, so that the aquarium becomes fouled.

This very abundant species is excellent for the aquarium if small specimens are kept. It is hardy, tames readily, and scavenges for lost food and bits of algae. Its habit of eating all the aquarium snails is but a slight drawback. However, specimens over 25 mm. long tend to eat the aquarium plants too.

Great Lakes Longear Sunfish
(Lepomis megalotis peltastes)

Appearance. Much like a dwarfed and more brilliantly colored edition of the previous species. The rather variable shade of its upper body is olive with irregular spots of orange and wavy streaks and spots of emerald. The belly is orange and very brilliant in the spring. The cheeks and gill covers are streaked with close, irregular lines of emerald. The flap or ear of the gill cover of the adult fish may project backwards one and one-half times the length of the snout, but in a younger fish may be proportionately shorter. This ear is black but may have a reddish margin behind. The red is very conspicuous in the breeding male, which is also distinguished by having black pelvic fins.

Size. Adult length rarely as great as 150 mm., usually about 100 mm.

Habitat. The sandy shallows of inland lakes and rivers such as the Huron in the southern peninsula of Michigan and southward.

Breeding Habits. Similar to those of other sunfishes and bass.

Food. Chiefly aquatic insects. Dried shrimp with occasional meals of living crustaceans, worms, or liver suffice for an aquarium specimen.

This species is a little harder to adapt to aquarium life than its mud-pond brethren, but is preferred because of its small size and brilliant colors, and because it is not a game fish. At present non-game fish may be taken and kept without a permit.

Pumpkinseed Sunfish *(Lepomis gibbosus)*

Appearance. This sunfish is another dwarf cousin of the Bluegill. The adult fish is so short, deep, and compressed as to seem disk-shaped. From above the color is olive to grass green, with flecks of green and gold. The sides are peppered with round blotches of dark olive or copper within a rim of dark green. Further down the sides there are streaks of turquoise blue between. The belly is orange yellow. The cheeks are orange with wavy emerald streaks. The flap or ear of the gill cover is small and velvety black except for a posterior spot of scarlet—the identifying mark of this species. The lower fins are orange.

Size. An adult 200 mm. or more long is a giant of its species.

Habitat. Small ponds and bays of larger lakes. It seems to have a slightly greater preference for clear water than the Bluegill.

Breeding Habits. The male, much like other sunfishes, fans out a nest in the bottom in shallow water. This nest may be 75 to 100

mm. deep and 300 mm. wide, and is often among reeds. The male elevates his gill covers to display their brilliant colors when trying to induce a female to enter the nest. Over the nest the pair circle and spawn. This same pose is also assumed by the male in driving off rivals. He defends the eggs and spawn until the young can care for themselves. Nesting is in June.

Food. Chiefly snails and small crustaceans. Dried shrimp with a couple of meals a week of snails, sieved clam, or similar living food constitutes a good aquarium diet.

The Pumpkinseed is a hardy little pond jewel. To the small boy its luster is not dimmed by its willingness to take a hook or by its numbers. Its hardiness makes it equally good for controlling mosquitoes in small ponds or for brightening up an aquarium. It is another of our fishes that has been used to stock European ponds. Although it is not inclined to uproot aquarium plants, small specimens are the most desirable.

THE PERCHES
(Percidae)

The perches are more or less compressed, small-scaled fishes, some of which are large enough to be used as food. All are carnivorous.

YELLOW PERCH *(Perca flavescens)*

Appearance. The yellow perch is too familiar as a market fish to require much description. The compressed body is rather high in the region of the dorsal fin. The rather small head is dished in above the eyes. The second dorsal fin is just behind the first one and is fairly large. The back is either a brassy green, shading off to yellow along the sides, or a pale greenish yellow. On each side

there are seven broad, green bars running from the back almost to the belly. The belly is yellowish white. The dorsal, pectoral and tail fins are gray-green. The pelvic and anal fins vary from greenish through orange to crimson, depending upon habitat and season.

Size. The adults may exceed 300 mm. in length.

Habitat. In deep, cool lakes and streams; particularly abundant in the Great Lakes.

Breeding Habits. This species is said to spawn in pairs on pebbly or sandy shallows. Sometimes after storms on the Great Lakes long windrows consisting of strings of perch eggs are to be found along the shore. The eggs are laid in April and May.

Food. Insects, crustaceans of all sizes, worms, snails, fish and fish eggs.

Small perch are interesting additions to an aquarium. They eat prepared foods readily but should be given some living food to maintain their health and color. Lean beef or liver can be substituted for aquatic animals.

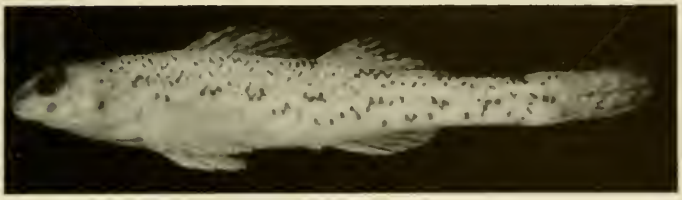
Central Johnny Darter
(Boleosoma nigrum nigrum)

Appearance. Once identified, a darter is usually recognizable at a glance. A description is of small help. The identifying characteristics are the combination of small size and a sparrowlike air of alertness, which is due to the darter's habit of resting propped up on the sand by means of the pelvic and anal fins. Furthermore, it can turn its head without moving its body and roll its eyes in their sockets. When startled it will sometimes bury itself in the sand with a great swirl so that when the sand settles only the great, protuberant eyes can be seen. This behavior is typical of the darters but of no other native fish.

This species is a pale straw color along the back and sides. Sprinkled over this color are brown dots and a series of indefinite W- and V-shaped blotches along the lateral line. The belly is pale green or golden. The pupil of the eye is black with a gold ring around it. The dorsal, tail and pectoral fins are barred with brown, the other

fins are whitish to straw colored. In the spring the male is bluish black on the head and on the first dorsal, anal and ventral fins. The body is clouded with the same colors. The fins are shaped much like those of the Yellow Perch.

Breeding male



Adult female

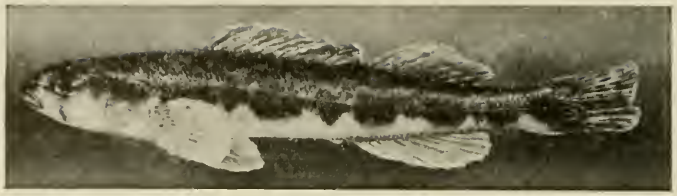
Size. About 63 mm. long.

Habitat. The open bottom of clear streams and lakes, including the Great Lakes. It lives on the open bottom, avoiding both thick weeds and stream riffles, the usual habitat of darters.

Breeding Habits. The male clasps the female with pelvic fins astride as she spawns. During the intervals when eggs are emitted the female raises a cloud of sand by vigorously beating with her tail. Possibly this sand covers them; if so, it gives them the only parental protection they get. Probably early May is the common spawning period in Michigan.

Food. In nature, *Chironomus* larvae and various small mayfly larvae. It will learn to eat dried shrimp, but in the aquarium seems to require occasional meals of living material.

This very hardy little darter of our quiet waters is most interesting in an aquarium. It makes up in curious behavior what it lacks in bright colors. No school aquarium should fail to have a few sometime during the year.



Blackside Darter *(Hadropterus maculatus)*

Appearance. Similar in shape to the preceding species. Its ground color is reddish brown. The back is speckled with black spots. The sides have patches of black which are larger and fewer in the male than in the female. There is a vertical black streak through the eye. The belly is creamy white. The fins of the male are all dusky, except for the first dorsal fin which is black with light spots along the base. The tail of the female has blackish cross lines. The first dorsal fin is long and low, the second short and high. This species too rests with its pelvic fins supporting it.

Size. About 70 mm. long.

Habitat. Chiefly the larger streams of southern Michigan, most commonly about holes in clay banks. It seldom frequents riffles.

Breeding Habits. Presumably similar to those of the preceding species.

Food. Water insects in nature, but it will eat prepared fish foods.

This species, like the preceding one, is hardy even in warm, silty water, and makes an interesting aquarium fish.

Northern Rainbow Darter *(Poecilichthys cœruleus)*

Appearance. More robust and more brilliant in color than the other darters. Its basic color is dark olive, overlaid with bars and blotches varying from smoky blue to indigo. The scales of the sides each have a dark central spot. Together, these spots form longitudinal rows, which are conspicuous in the paler females. In the male the spaces between the eleven or twelve bars are orange-red

and the head is flesh color with lavender on the chin and orange on the gill covers. The forehead is bluish black. There is a spot of blue below the eye and a dark spot behind it. The spiny first dorsal fin has two bands of indigo blue with an orange red band between them and another orange band at the base of the fin. This band is broken by red spots. The female is duller, with side bars of dark, smoky blue. Its first dorsal fin has an edge of pale blue, below which there is a straw colored band with a row of rust colored spots.

Size. About 50 mm. long.

Habitat. The riffles of streams in the southern third of the southern peninsula of Michigan and southward.

Breeding Habits. The females are reported to deposit their eggs in gravel in May. The brilliant breeding colors of the male persist all summer.

Food. *Chironomus* and mayfly larvae in nature, prepared foods in the aquarium.

Although lacking the grace of the other darters, this colorful little fish has been carried around the world by aquarists.

It should be given an aerated aquarium or placed in very shallow water, for it requires a great deal of oxygen.

THE CARPS AND MINNOWS
(Cyprinidae)

The carps and minnows are of varied shapes, the carps being deep and heavy-bodied and the minnows proper mostly slender. The head is without scales, while the body, in our forms, is covered by scales. A more complete account of this interesting and important group may be found in *Minnows of Michigan,* by C. L. Hubbs and G. P. Cooper.

Carp *(Cyprinus carpio)*

Appearance. Thick-bodied, humpbacked, covered with coarse scales overlaid with a blanket of mucous; color, muddy to olive brown.

Size. 600 mm. long.

Habitat. Shallow lakes and warm bays and sloughs, wherever introduced.

Breeding Habits. During the early mornings of May and June a single female carp pursued by four or five males will dash through the dense vegetation of some shallow bay. Amid much splashing she deposits 500 or 600 eggs at a time. This boisterous egg laying continues until her 400,000 or more eggs are gone. The scattered eggs adhere to plant roots and stems, where they hatch in about twelve days.

Food. Anything of animal or vegetable origin in any form, even if decayed.

This fish is hardy but undesirable in the aquarium. It is ugly in appearance and will root out the planting in an aquarium. Its one virtue is that it supplies food to many a poor man's table.

Goldfish (*Carassius auratus*)

Appearance. Full bodied, very deep in the middle; sometimes weirdly shaped; protruding eyes or abnormal fins; black, brown, white, or pale gold to red in color, the light colored young often with temporary black spots or blotches.

Size. 300 mm. or more in length.

Habitat. Warm, shallow lakes and rivers, where introduced by man.

Breeding Habits. During June the males pursue spawning females. The females swim into dense mats of vegetation where, often with much flapping at the water surface, some of the males fertilize the eggs. Accompanying goldfish of both sexes eat all the eggs they can find.

Food. Similar to that of the carp; anything vegetable or animal that they can swallow.

Although attractive in color, goldfish are undesirable in the aquarium when they are more than 60 or 70 mm. long, for their hoglike rooting dislodges all aquarium plants and their huge appetites result in their fouling the water as do few other fishes.

Western Blacknose Dace (*Rhinichthys atratulus meleagris*)

Appearance. Slender; dark gray or grayish brown above, silver beneath; back speckled with dark scales, frequently with additional black spots caused by parasites lodged beneath the skin; the pectoral and anal fins rather large; two minute, fleshy feelers (barbels on upper jaw).

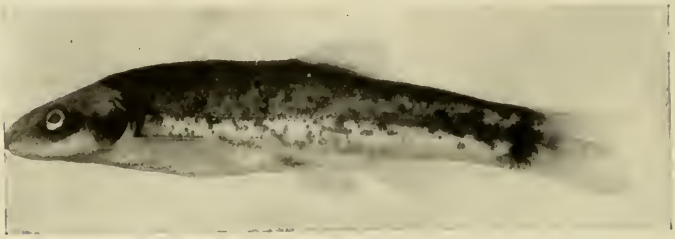
Size. 90 mm. in length.

Habitat. Rapid streams.

Breeding Habits. The fish mate in the riffles of a stream. There is no nest and no care of the eggs, which are merely released over

gravel. There seem to be spawning areas, however, which one male defends from all others.

Food. Aquatic insects and possibly algae, but it will learn to eat dried shrimp and similar prepared fish foods.



Since this species is a stream fish it requires more oxygen than many others and should be kept in running water if possible. It might be induced to spawn in an aquarium, its spawning temperature being 70° F.

Finescale Dace *(Pfrille neogaea)*

Appearance. Slender, with a single dark stripe along the length of the body, the male with bright red on the lower part of its sides; the mouth large and straight; the body covered with scales so fine as to be seen only with the aid of a lens.

Size. Adults reach almost 100 mm. in length.

Habitat. Chiefly the bog streams and small lakes of all but the lower third of the lower peninsula of Michigan.

Food. Aquatic insects and probably algae. Will learn to eat dried fish foods.

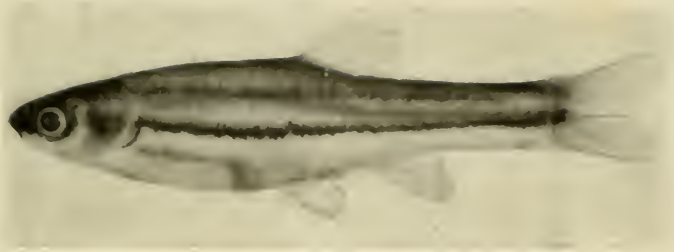
This fish proves to be relatively hardy in the aquarium once it has become adjusted to the new conditions.

Northern Redbelly Dace *(Chrosomus eos)*

Appearance. Very much like the preceding species, but with a shorter snout and a more oblique mouth.

Size. Adults, about 65 mm. long.

Habitat. Bog ponds and bog streams, beaver ponds, and similar



places in both peninsulas of Michigan, except in the Lake Erie drainage.

Breeding Habits. The active gravid female attracts the attention of one or more males, which then pursue her into a mass of thread algae, where she spawns for several seconds. She then dashes on from one mass of algae to another until spent. The non-adhesive eggs entangled in the algae hatch in eight to ten days. Spawning may occur from late May into August, and each female probably spawns twice.

Food. Chiefly thread algae and bottom ooze. Can be fed Pablum and dried shrimp in captivity.

The Northern Redbelly Dace is a very desirable aquarium fish and might be induced to spawn in captivity if given the proper conditions.

Southern Redbelly Dace
(Chrosomus erythrogaster)

Appearance. Slender. Two dark lines on either side, one running from the top of the head along the lateral line to the upper half

of the tail, the lower and broader stripe from the mouth through the eye, to end as a black spot on the tail fin. The color of the back is greenish brown, with a row of greenish spots on either side. The space between the dark lines of the sides is a silver or satiny cream, with a brassy tinge in the males. The belly is cream color, tinged with a rose in the males, except in the spring, when the belly, breast and chin are bright scarlet. The fins are pale amber, except in the breeding males, in which they are lemon yellow, the dorsal fin having a scarlet base. The body of the breeding male is finely pebbled.

Size. Adults, about 75 mm. long.

Habitat. In clear, gravelly streams in the southernmost part of Michigan, and southward to Tennessee.

Breeding Habits. Spawning occurs in June.

Food. Chiefly algae and small insects from the bottom. In the aquarium it can be fed crumbled rolled oats or Pablum, with a pinch of dried shrimp.

This dace is a fine aquarium fish once it becomes accustomed to captivity, and is gaudy enough to be sold here and abroad as an exotic fish.

Western Golden Shiner
(Notemigonus crysoleucas auratus)

Appearance. The body is deep, slab sided, laterally compressed, with a fleshy, scaleless keel back of the pelvic fins. The fins are sharply angled instead of rounded, the anal fin usually sickle shaped. The head is small and triangular. The lateral line sweeps

sharply downward toward the belly, and there is a fleshy, scaleless keel on the belly, back of the pelvic fins. The young are a clear, greenish brown above, sometimes with a faint line along the middle of the back and a dark line along the side. As the fish gets older this color changes toward a solid and brilliant golden color.

Size. The maximum length of the adult fish in Michigan is about 250 mm., the average length nearer 150 mm.

Habitat. The weedy shallows of lakes and river bays. Very abundant in some of our sewage-polluted streams.

Breeding Habits. Not well known. The eggs are to be found adhering to water plant stems and roots and among algae, according to various reports.

Food. Almost anything animal or vegetable, but the preference is for water fleas and other small crustaceans.

The golden shiner is an attractive aquarium fish, but its fondness for all sorts of plant and animal food, including small fishes, makes it necessary to keep this species by itself as soon as it reaches several inches in length.

Northern Redfin Shiner
(Notropis umbratilis cyanocephalus)

Appearance. The body is strongly compressed and deep, particularly in larger fish. The scales are large, darkened at the edges, but is more slab sided. The color is dark blue to purple along the back. The sides are smoky greenish blue fading out to a pale smoky green on the belly. A dark band starts at the base of the tail and runs forward, getting fainter until it disappears. There is a dark

spot at the front base of the dorsal fin. The fins of the breeding male are bright red with greenish bases, and the head is blue.

Size. Adult, about 75 mm. long.

Habitat. Common only in large, sluggish, muddy streams of southeastern Michigan and southward.

Breeding Habits. Spawning occurs in June.

Food. Chiefly small crustaceans and insects.

This minnow is a colorful aquarium fish. Little is known about its behavior in captivity.

Northern Steelcolor Shiner
(Notropis spilopterus)

Appearance. The body is strongly compressed and deep, particularly in larger fish. The scales are large, darkened at the edges, distinctly diamond shaped on the front third or more of the fish, an unusual characteristic helpful in identification. The eye is small in proportion—less than one-fourth the length of the triangular head. The appearance is brilliantly silver, with a dark line along the middle of the back from head to tail. The small mouth slants downward, the upper jaw concealing most of the lower. The breeding males are among our most beautiful minnows. The back is olive green, shading along the sides into metallic silver underlaid with tinges of blue, green, and lavender. The under parts are paler, or satin white. The male dorsal fin has a prominent black spot posteriorly. The fins on the underside of the body are yellow and, like the other fins, may have milky white edges. Tiny tubercles ornament the top of the head and body of the breeding male.

Size. Adult length, 76-100 mm.

Habitat. Running streams or clear lakes where the sand and gravel are clean and free of vegetation. Increasingly common in the southern peninsula of Michigan.

Breeding Habits. These minnows seem to spawn in schools and lay their adhesive eggs in clusters on submerged logs and other objects near shore.

Food. Chiefly aquatic insects and various more or less microscopic plants and animals.

Although relatively uncommon in Michigan, this minnow promises to be an interesting addition to the large aquarium.

BLACKCHIN SHINER *(Notropis heterodon)*

Appearance. The chief distinguishing marks are the black-tipped chin and a dark band running from the nose back through the eye to the tail. The adults are noticeably humpbacked. The color is dusky olive above; dull silver along the sides, except for the black stripe; and silvery white, tinted with orange, underneath.

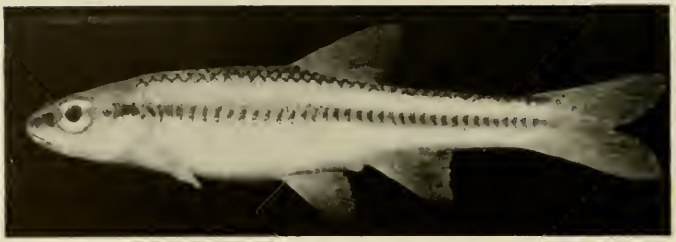
Size. Adult length about 47 mm.

Habitat. Smaller lakes and occasionally weedy streams.

Breeding Habits. This species spawns in May and June.

Food. Preferably small crustaceans, such as water fleas, but other animals and plant material are also eaten.

Once used to an aquarium, this fish is relatively hardy. As with many other captive fishes, occasional meals of living water fleas, mosquito larvae, etc., are important.



Northern Blacknose Shiner
(Notropis heterolepsis heterolepsis)

Appearance. Similar to that of the Blackchin Shiner, but more slender, and with a black band running around the snout above the mouth, rather than through the chin.

Size. About 70 mm. long.

Habitat. In weedy streams and ponds and in shoals of the Great Lakes.

Food. Small crustaceans, insects, and plant material.

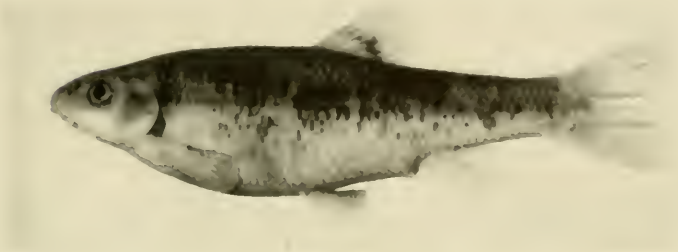
This species is common and relatively hardy.

Central Stoneroller Minnow
(Campostoma anomalum pullum)

Appearance. A spindle shaped fish with a deep groove between the lower jaw and the fleshy lip. The color is olive brown above, with brassy glints; the sides are blotched with black, with a dark bar behind the gill cover; the belly is satin white. The males have a dark bar across the dorsal and anal fins and a vertical bar at the base of the tail fin, very conspicuous in the breeding season. The male is distinctly humpbacked and has fleshy lips that make him look like the endman in a Negro minstrel show. The snout and whole body of the male become covered with short spines during the breeding season. Young fish may be pinkish or magenta color. Within this fish is hidden a peculiarity which is a positive identification—the long coils of the intestine are spirally wound around the air bladder.

Size. Length of adult males 150 mm.; of adult females about 125 mm.

Breeding male



Gravid female

Habitat. Gravel and sand-bottomed streams in the southern half of the southern peninsula of Michigan and southward.

Breeding Habits. The male excavates funnel shaped depressions several inches deep in sand and gravel. Apparently the rough tubercles are of some assistance in digging as well as in the battles he fights with other males as he defends his nest. A female is enticed over the nest, where she is held firmly, again with the aid of the tubercles, until her eggs are laid. Possibly more than one female contributes eggs to the nest.

Food. Mostly thread and encrusting algae and other microscopic bottom material. Some insects and small crustaceans are eaten, particularly by the younger fish.

Few native fishes are so well adapted to an aquarium as this species is. It readily adapts itself, eats the bottom ooze found in sunny tanks, and is peaceable. If adults are caught during the winter or very early spring they will show breeding activities soon after being brought in.

THE CATFISHES
(Ameiuridae)

Our catfishes are large headed and wide mouthed. They are naked, having no scales, so that the muscles going either way from the lateral line are clearly visible. The first ray of the dorsal and pectoral fins ends in a sharp and sometimes poisoned spine. There are four fleshy feelers or barbels above the mouth and four below. They are covered with taste buds and evidently help the fish to secure food on muddy bottoms, where they feed, chiefly at night. In general they are brownish or greenish above, creamy white underneath.

As a group, catfishes do well in an aquarium. Unfortunately, most of them grow large, so only the young are desirable.

Northern Black Bullhead
(Ameiurus melas melas)

Appearance. A typical catfish, brownish or greenish black, with golden glints above. Occasional individuals are yellow. The under parts are yellowish green. The fin membranes are blackish and have much lighter supporting rays. The relatively short anal fin is decidedly rounded, almost semicircular in outline. The tail, however, is rather sharply angled behind. The barbels are gray to black.

Size. Adults occasionally reach 300 mm. in length.

Habitat. Muddy ponds and small sluggish streams. It is particularly common in the waters of the Great Lakes plains.

Breeding Habits. This species breeds in May in quiet pools or

bays. The eggs and small young are guarded by the parents. A family procession consisting of both parents and the young can often be seen. The male seems to be the more active and persistent guardian.

Food. Bottom debris, both plant and animal. It will eat insects, meat, bread and almost anything else that is edible.

Small specimens make particularly good aquarium fish, for they clean up the tank and are also fairly hardy. Large catfish stir up the water too much and are quite capable of eating or injuring other fishes.

Northern Brown Bullhead *(Ameiurus nebulosus nebulosus)*

Appearance. Similar in shape to the black bullhead but somewhat more compressed laterally. The barbels of the upper jaw are of the same color as the head, those of the lower jaw are slaty to pinkish white and occasionally have darker blotches. The fins are lighter than in the preceding species. The anal fin is long and ovoid. In color this species varies from dark to yellowish brown above, with darker blotches which may be almost black. The under parts vary from light gray through pale pink to satin white, and are sometimes mottled with darker shades.

Size. Adult length up to about 450 mm.

Habitat. Muddy ponds and rivers.

Breeding Habits. Similar to those of the black bullhead, including the family processions.

Food. Small mollusks, insect larvae, and any debris of edible nature.

This species is hardy indoors as well as out, but is desirable only when small, owing to its rooting habits. This species is also called the Speckled Bullhead and the Common Bullhead.

Yellow Stonecat *(Noturus flavus)*

Appearance. Small, slender, distinctly flattened at the head end and usually a rather uniform olive green above. The back color is

occasionally blackish green. The sides shade to yellow or yellow brown. The belly is white. The dorsal fin is short and behind it the adipose fin, which is a distinct projection in the preceding species, grows backward along the back and is separated from the tail by a slight notch. This blending of the adipose fins is also character-

istic of the much less common little madtoms. The Yellow Stonecat, however, is a long slender fish which is flattened from the dorsal fin forward, while the madtoms are higher in proportion and more heavy-bodied in the region of this fin. The barbels of the upper jaw are blackish, but those of the lower jaw are yellow, like the chin. Small spines of the pectoral fins are poisoned and cause great pain if they break the skin.

Size. The adult length seldom reaches 225 mm.

Habitat. In the swift waters of large streams and small rivers, where it hides under stones. It never occurs in stagnant or muddy waters.

Breeding Habits. The eggs are laid in late June under flat stones or boards. They are watched by the male. After the eggs hatch the fish remain in or near the nest for a while.

Food. Chiefly small crustaceans and water insects.

The yellow stonecat is an interesting little fish that might spawn in the aquarium if collected in the spring. Aeration might prove desirable. It should be handled with a net to avoid painful contact with the spines.

Amphibians

The amphibia are readily distinguished by having moist, soft, scaleless skins. The young go through a gilled stage, usually under water, at which time they are called tadoples. The adults usually lose their external gills, acquire lungs, and thereafter live on land most of the time or for more or less extended periods.

There are two main types of amphibia here—the tailed forms, or Caudata, to which our salamanders belong, and the tailless, jumping Anura, to which our various frogs and toads belong.

THE PERMANENTLY LARVAL SALAMANDERS (Proteidae)

This family breaks the general rule that amphibians transform from water animals with gills to air-breathing animals with lungs. It members go through life lacking eyelids and with their fringe-like gills hanging from either side of their throats.

MUDPUPPY *(Necturus maculosus)*

Appearance. A large, heavy-bodied salamander with three conspicuous red gill fringes on either side of the head. These gills are

never lost, since this species never loses it larval characteristics. The tail has a wide finlike margin of skin near the tip. The ground color varies. It is usually reddish brown above, with an undercolor of blue-black which shows through in irregular spots. The brown is faintly speckled with white. The belly may be white or creamy, or have only a narrow light stripe down the middle.

The young mudpuppy has a very dark back, bordered on either side by a narrower yellow band extending from the eyes along the back, to fade out toward the tip of the tail. Between these, following the ridge of the back, there is a light hair line which runs from a point opposite the gills to the tip of the tail. The sides of the head, body and tail are deeply pigmented, the pigment fading out below into a pale, and in the newly hatched larva, a yolk colored belly. There may be light spots scattered through the length of the dark sides. The limbs are short and end in stubby toes. During the first few weeks the gills are prominent, but by the time the Mudpuppy is seven weeks old the filaments are shortened to comblike proportions, such as they were at hatching.

Size. 280 mm. long when adult, occasionally over 425 mm.

The larva is about 22 mm. long at hatching. The Mudpuppy is reported to reach a length of 55 mm. during the first year.

Habitat. This salamander lives wholly under water, inhabiting muddy creeks, ponds and lake bays, as well as the clear waters of the Great Lakes.

Breeding Habits. There is some evidence that the male Mudpuppy, like the male Newt, courts the female by crawling over and around her. Just how the female is fertilized is not known. The male does form a stalked spermatophore some 10 mm. long and 6 mm. wide, but such spermatophores have never been observed in nature. In an aquarium they are not attached, as are those of many other salamanders.

The breeding season may be quite extensive, for females have been found with spermatophores in their vents as early as October, while males have been found with enlarged cloacal glands as late as April.

The eggs are deposited on the under sides of boards, logs, or stones lying in two to four feet of water. The female turns upside down to go into her own nest or a communal one. There she lays her ninety or more eggs upon the roof of the nest. Depending upon conditions, the eggs may be spread over an area over 300 mm. in diameter or crowded into a space half that wide. An egg is about 7 mm. in diameter, but with its envelopes is about 11 mm. wide, and hangs to a length of about 15 mm. The egg is unpigmented. Hatching takes place from mid-July into August.

Food. Aquatic insects, worms, leeches, crayfishes and small crustaceans, fish and fish eggs—in fact, almost anything. In the aquarium, earthworms and bits of fish or liver, particularly if they are moved about to simulate life, are readily taken. At night the Mudpuppy feeds chiefly in clear water, and all day in dark and muddy waters.

This salamander is particularly interesting because it is so large that the larval characteristics can be seen very readily. It is quite hardy, provided it is given a preliminary bath of water slightly tinted with potassium permanganate or mercurochrome to destroy the fungus that often attacks it after it has been handled.

Many fisherman claim that the Mudpuppy is poisonous, which is not true. However, it can deliver a quite noticeable bite and it also discharges a disagreeable sheet of slime when annoyed.

THE NEWTS
(Salamandridae)

The Newts are slender salamanders with narrow heads and strongly compressed tails. The tail of the breeding male has a high, wavy fin, that of the female a distinct but narrower fin. They have movable eyelids. The feet have four toes.

Newt *(Triturus viridescens)*

Appearance. A slender, flattened little salamander with large eyes. The upper jaw extends beyond the lower one. The legs are

slender; the front legs are about half the size of the hind ones. The skin is finely wrinkled. The aquatic adult is olive green to reddish brown above, with a row of black-rimmed red spots running down either side of the middle, and sometimes fusing into two irregular lines. The body is peppered with black spots. The underside of the body is lemon to orange-yellow and is separated from the back by a dense row of black spots along either side. The sides of the tail

Newts in the aquatic phase

have two dark lines with a light line running between them. The tail is somewhat longer than the combined length of the head and body, and is keeled in the aquatic adults.

The terrestrial, immature Newt varies from dull reddish brown to bright orange-red in color. Its skin is rough, and the tail is oval.

The larval Newt is greenish brown. During late summer it absorbs its double fringe of reddish gills and turns vermilion on the back, orange-yellow below. It may or may not have a sprinkling of black spots. The skin then becomes rough and the tail lacks the keels of skin.

The land form and coloration may be retained until the end of the second or third year, when the animal matures and returns to the water.

Size. The adult length is about 100 mm.; that of the immature land form, about 70 mm.

Habitat. The Newt starts out life in a fishless woodland pond or a weedy bay. After about four months it changes to its air-breathing form and goes to live under and around logs and stones in damp woods. There it stays for two or three years, until sexually mature. It then migrates back to the water, where it lives the rest

Newt in the land phase

of its life unless the pond dries up, in which case it may hibernate under some log. The Long Island Newts omit the land stage, and I have been unable to find this stage here in an area where larval adults are plentiful in the woodland pools.

Breeding Habits. The breeding habits of the Newt have already been described in part at the beginning of the section on amphibia. During the fall the pairs couple in a love play which may last an hour or so and may continue on sunny days throughout the winter. In April the male glues club-shaped spermatophores to the bottom debris and the female takes one into her vent. Soon the female swims up to a leafy water plant, grasps a leaf between her hind legs, bends it down and deposits a single egg. She then bends the leaf back over the egg in such a way as to conceal it. Egg laying may continue for weeks. The eggs hatch in 20 to 35 days at outdoor temperatures.

Food. The newly hatched Newts seem to eat algal ooze and microscopic crustaceans, but I have never been able to rear them to the land stage on such a diet. Older Newts eat worms, insects of

many kinds, young snails, tadpoles, bits of lean meat, and even dry fish foods.

There is no better aquarium pet than a Newt. It is vividly colored, easily tamed, hardy, and active in the daytime. Since the adult breathes air, a number of Newts may be kept together in one tank. The only special care that must be observed is to prevent them from escaping. A Newt can climb even one of the vertical corners of an aquarium, and the container should therefore have a lid.

In order to have an attractive display of Newts, plant the aquarium rather densely at the ends. The middle should be left open except for a dense clump of fanwort (*Cabomba*). The tank should be placed where it gets an hour or two of direct sunlight. A stone or log should project above water. Under these conditions Newts are active, easily seen, and attractive.

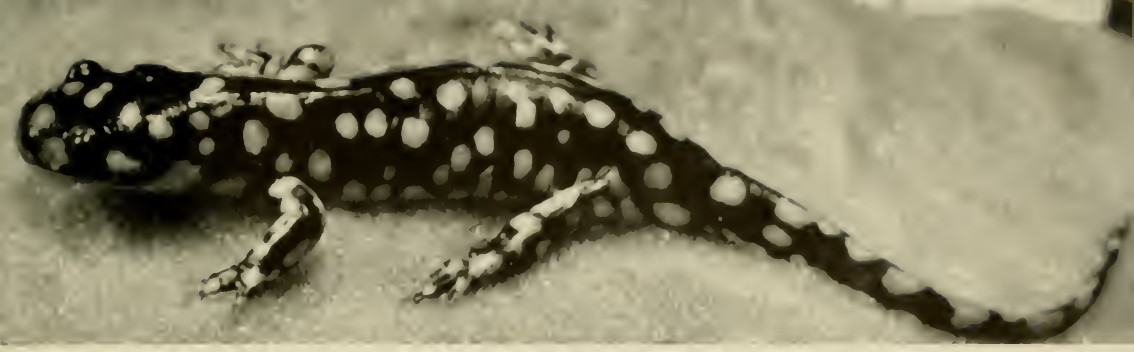
THE AMBISTOMIDS
(Ambystomidae)

These are the five-toed salamanders with blunt, flattened, bulldog heads and heavy, bluish black or brownish black bodies, mottled with large spots. Although natural inhabitants of moist forest land, they frequently wander through window holes and into basements when seeking a place to hibernate in the fall.

Spotted Salamander
(Ambystoma maculatum)

Appearance. This salamander looks like the Tiger Salamander, except that along its side the bluish black ground color blends with the slaty gray of the belly, and its yellow spots are relatively few, distinctly larger than the eyes, and placed in two rather irregular rows along the back. These spots vary from dull yellow to orange. The head tapers little or not at all toward the back, and the fold at the neck is rather shallow. The toes of this species are long and pointed.

The newly hatched larva, which is some 12 mm. long, has a slender body. A balancer projects backward from the side of the



head just beneath and to the rear of each eye. From the rear of the head project three pairs of gills, each with a few stubby filaments. The front legs consist of short, toeless stubs. The tail fin starts just behind the forelegs, is broadest back of the vent, and tapers to an abrupt point.

At this stage the larva is greenish yellow, with areas of olive on the head. There are also black spots on the head, continuing posteriorly as an irregular band on either side of the back. Below these bands lies an area with little color. Below these areas, again, there is a slightly pigmented band. In short, the larva is distinctly three striped in side view. The tail fin has irregular spots of gray and yellow.

The mature larva is usually about 50 mm. long, but may be a third larger or smaller. The head is broad and blunt nosed, and widest at the point of attachment of the gill remnants. The rather

Spermatophores of the Spotted Salamander

slender body tapers gently to the end of a heavy tail. The legs and toes are slender and long. The color is variable. It may be dark brown above and paler along the sides, or it may be greenish gray above and bluish along the sides. Along the upper sides and tail are small yellow spots, those on the trunk being in about the same position as the spots of the adult. Beneath, the throat is white, the belly grayish and iridescent. The tail fin starts opposite the insertion of the forelegs.

Eggs of the Spotted Salamander

At the time of leaving the water the yellow markings may be greatly intensified, the toes are shortened, and the gills and tail fin are lost.

Size. The adult size, about 170 mm., is intermediate between that of Jefferson's Salamander and the Tiger Salamander.

Habitat. This species usually spends the summer and fall periods of its adult life hidden beneath logs, in tree stumps, and beneath the loam of upland stands of hardwood. It comes out to feed only at night. In the late fall and early winter it seems to wander

widely. Like others of this genus, it migrates toward its breeding pond when the first warm spring rains come. The breeding pond is usually a temporary woodland pool or a slow stream, but it may go to bog ponds or lake marshes.

Breeding Habits. Its breeding habits are essentially like those of the Tiger Salamander, except that when Spotted Salamanders have gathered in numbers they make the water "boil" as they swim over and over one another in their nuptial play in late March or early April.

The eggs are deposited in oval or rectangular masses about 11 mm. long and attached to submerged branches or vegetation, often with as many as 150 in a mass. The egg is about 3 mm. in diameter, brown at one end, yellowish at the other. The eggs appear as dark balls enclosed in a milky gelatin. Covering the eggs and their support is a clear or milky gelatinous mass.

Food. The adults eat much the same small land creatures as the Tiger Salamander does—earthworms, slugs, snails, ground insects, etc. Unlike the Tiger Salamander, they seldom or never catch frogs or other salamanders. In captivity this species will eat bits of meat, but not readily. The larval Spotted Salamander eats water insects, crustaceans, and small fish.

This species is hardy in the vivarium or aquarium. I prefer to keep it in an aquarium containing an inch or so of water, with one or more flat stones protruding. The temperature should be under 70° F., and may be much cooler. Like other ambystomas, this species is torpid in daytime and only slightly more active at night.

Tiger Salamander *(Ambystoma tigrinum)*

Appearance. A chunky, blunt-headed salamander covered by a glistening coat of mucous, typical of the Ambystomas. The head is widest just back of the eyes and tapers gradually to the neck, which is marked by a deep and narrow groove. The toes are bluntly tapering and short. The ground color of the sides and back is dark brown or dull black, with numerous light yellow-brown or olive brown spots about the size of the eyes. These spots are irregular in size and shape and frequently fuse to form light blotches

or stripes. Along the sides, just above the olive yellow belly, there is a row of yellow spots or bars or a broken yellow line which distinguishes the species from the equally common spotted salamander, which has sides of a uniform slate color. The underside of the Tiger Salamander is an olive yellow more or less blotched with olive.

The newly hatched larva is some 14 mm. long. From above, the head appears almost circular. There are three gills to a side and they have almost no filaments. There are no legs. The prominent dorsal tail fin starts just behind the head.

The color from above is yellow-green. There is a dark band covering much of the head and back. Along the back there are about six pairs of dark spots. There is another dark band low on either side, with a light, rather spotted band. In side view this species is distinctly banded.

The mature larva, which is about 100 mm. long, has a shovel-shaped head and large, profusely filamented gills. The body is tapering. A wide fin runs from back of the head around the tail to the vent. At this stage the larva is dark brown to black above and creamy silvery beneath, except on the throat, which is bluish.

Size. Usually between 175 and 225 mm. The male tends to be distinctly larger.

Habitat. The adult lives in deep burrows beneath old logs, in piles of decaying vegetation or manure, in drain pipes, and even in

abandoned animal dens. During the summer and fall the salamander leaves its den only at night, when it forages for food. In the fall these forays seem to lead it further afield and it often falls into excavations and window holes. I once had forty-nine brought from a home situated in an oak-hickory woods. I know of two that survived a winter in separate window holes.

As a rule the young salamander hatches from eggs laid in a more or less temporary pond. I find it frequently associated with the Newt. It leaves its pond in late August.

Breeding Habits. During the first warm rainy nights in March the Tiger Salamanders gather at their breeding ponds. Often an appreciable amount of ice still remains on ponds located in the woods. The breeding activities are known from watching pairs placed in an aquarium lighted by photographer's red lights. The male butts the female vigorously in the region of her vent. Finally he stalks ahead, rubs his vent on the bottom, and deposits a spermatophore. During the emission of the spermatophore his feet are raised off the bottom. The tail is raised at right angles to the body and undulated. At the same time his body moves convulsively. Meanwhile the interested female has been resting with her muzzle close to the vent of the male. When he moves on she follows him until her vent is over the spermatophore. She then repeats the motions of the male as she encloses the spermatophore with her vent. Apparently the female shows little interest in a spermatophore not deposited during courtship.

In late March or in early April the female deposits some fifty eggs, which are to be found as masses attached to submerged twigs or vegetation in about 30 cm. (1 foot) of water. Each egg is some 3 mm. in diameter. One end of the egg (the animal pole) is brown, and the opposite half (the vegetable pole) is cream colored. Around each freshly laid egg there are three distinct envelopes of clear jelly. A fourth layer forms a mass that envelopes all the eggs and holds them to their support. The eggs probably hatch in about three weeks.

Food. This species has an appetite that belies its daytime appearance of sluggishness. The adult will eat earthworms, various

insects, small mice and frogs, other salamanders and salamander eggs. In captivity it will learn to eat bits of beef, at night. The young eat aquatic insect larvae, daphnia and other small aquatic animals.

This interesting salamander thrives in captivity. It eats living food readily and voraciously. Even smaller members of its own kind are included in its diet.

The aquarium should contain moist earth, with a flat rock or decaying board lying at the surface to supply a roof to the salamander's burrow. However, I frequently keep a specimen in shallow, cold (60°-70° F.) water containing a few stones. Under the latter conditions it is easier to view its activities.

THE PLETHODONTIDS
(Plethodontidae)

The Plethodontids are small, slender salamanders which undergo their gilled stage in the egg. They have movable eyelids and are much more terrestrial than most salamanders. However, they must live close enough to water to be covered by wet moss, earth, or decayed wood. The tail is more rounded than compressed and lacks a fin. The fore feet have four toes; the hind feet five.

Four-Toed Salamander
(Hemidactylium scutatum)

Appearance. This, our smallest salamander, is distinguished readily by having but four toes on each foot and having a conspicuous constriction of the tail just back of the vent. This constriction marks the region at which the salamander can shed its tail. The head is broad and flat. The snout of the female is bluntly rounded; that of the male is abruptly cut off. The male is about a third smaller than the female, is more slender, and differs in color.

The color of the female is reddish brown above, fading to gray along the sides. The upper surface of the legs and tail is deep orange marked with brown. There are small, light red patches

above the shoulders and flecks of the same color in the grooves of the back. The underside is bluish white, with many flecks of black along the outer edge, fewer in the middle.

The male has a band extending along the back from head to tail. On the top of the head and on the tail behind the constriction the color of the band is reddish brown. In between, along the back, it is light bluish brown. The snout, the area just above each shoul-

der, and the upper joints of the legs are bronze. On either side of the brown band, along the sides, are many black spots and small, bluish white flecks. The blue flecks predominate on the lower sides. The underside is bluish white with small, black spots.

The larva is about 12.5 mm. long at hatching. Its broad head is widest halfway between the eyes and gills, and ends in a blunt snout. The forelegs are well developed and may have four toes. The short hind limbs are directed backward and may be entirely toeless. The tail is keeled above. This keel or dorsal fin extends forward almost to the head. The lower fin runs forward only to the tail constriction.

The head of the larva is tinged with orange, green and yellow marked with brown or black pigment spots which may form a Y with the open end at the snout. The gills are black with orange bases. The back is a light greenish yellow above, bordered by dark, irregular markings. As the larva matures this coloring deepens.

Transformation appears to be complete by the end of July.

Size. Adult males about 65 mm. long; adult females, about 75 mm.

Habitat. During the summer and fall they are commonly found under stones and logs in woods adjoining their upland breeding ponds. During the breeding season they are to be found within about six inches of water, buried in the moss or moss rhizomes and grass roots covering a rotten log.

Breeding Habits. During the late summer and fall the male nuzzles the head and sides of the female until he has stimulated her interest. She then follows him about, her chin pressed against the base of his tail. He deposits one or more spermatophores, one of which she takes into her vent.

In April the female migrates to the nesting grounds with her fellow females. There, in a hollow some inches beneath the surface of the moss, she lays her eggs. The female crawls upside down as she deposits her eggs. Each is tucked among a few strands of moss, but the complement of about fifty may form a single mass. The female guards her eggs for the sixty odd days that are required for hatching.

Food. Springtails, spiders, small flies, hemiptera and beetles.

These salamanders are so small and retiring that few people realize that they exist. Although interesting to the serious student, their inactivity and insistence upon hiding would make them of little interest were it not for the possibility of having them lay their eggs in captivity.

Although sluggish and retiring by nature, the Four-toed Salamander sometimes squeaks when annoyed and can leap away rapidly.

When handling this species it is wise to remember that the tail readily parts from the body at the constriction—an interesting phenomenon.

Red-Backed Salamander
(Plethodon cinereus)

Appearance. This species too is small, being only a little larger than the tiny Four-toed Salamander, but the more slenderly proportioned body and prominent eyes give it a more active appearance. Note that it has five toes on its hind feet, four on its fore feet.

There are two color phases to be found in this species, often side by side. A red-backed specimen has a wide stripe running from the eyes more or less to the tip of the tail. The stripe may vary from gray through yellow and pink to bright red. The sides next to the central stripe are black or dark gray. This color fades into mottling near the belly. The belly is mottled gray and white, and slightly pinkish at the throat. In the other color phase this salamander is dark brown to black. The belly is mottled gray and white, as in the other phase.

The larva is about 20 mm. long at hatching, which occurs some-

time in August. In general pattern it usually resembles the color phase of its mother. The gills may reach their fullest development just before or just after hatching. In any case the gills disappear within a few days after hatching, and at no stage can the hatched larva be considered aquatic.

Size. Males average about 73 mm. long and females 78 mm.

Habitat. This species is relatively independent of water. It seems to prefer deep conifer woods but is frequently found also in mixed deciduous woods. Sometimes it is abundant near woodland streams and may be associated with Jefferson's Salamander or the Four-toed Salamander.

Breeding Habits. Mating has not been observed, but dissection reveals that it probably takes place over a considerable period of time, from the last of October until April. In July or August the female lays her eggs on the roof of a burrow located in a rotten and crumbling log. The eggs are always in a crevice small enough to allow the female to remain with her body in contact with them until they hatch. Often several females with their eggs will be found in a crevice near the end of a particularly suitable log. The eggs may also be laid under loose bark, moss, or stones.

An egg cluster usually consists of from three to thirteen eggs. The eggs are usually, but not always, suspended from the roof of the nest crevice.

Food. The adult apparently prefers ants, but also eats insects of many other sorts, as well as earthworms, roundworms, snails, sowbugs, spiders, mites and millipedes.

This species can be so independent of aquatic situations that it might properly be excluded from an aquarium guide were it not for the fact that it is often associated with forms which do have aquatic stages and with which it might be confused.

Like the four-toed species, this lively little salamander leaps with its tail. Although it does not have an obvious breaking point on the tail just back of the vent, it too can run off, leaving a raw-tipped stub which leaps and wriggles about in a manner calculated to distract an enemy. However, such an event by no means always occurs, for it often remains coiled and motionless when exposed.

THE TRUE FROGS
(Ranidae)

The true frogs are chiefly distinguished externally by their smooth skins and by the fact that, though they may wander away from the water, they usually prefer moist areas.

Northern Wood Frog *(Rana cantabrigensis)*

Appearance. This frog can be recognized immediately by the dark brown, triangular mask which runs from the nostril back across the eye and ends behind the ear. A white line runs along the edge of the upper jaw, just below the mask. On each side a more or less broken, dark brown line may run backward from the top of the mask almost to the thigh. There may also be a pale line along the length of the backbone. The ground color is brown above, varying from an ashy fawn color through reddish brown to a dark, leaf brown. The underside is yellowish white, occasionally mottled with brown.

The tadpole is grayish brown above, flecked with gold, and is iridescent gray bronze beneath. The fin does not extend up on the body.

Size. Adult length 36 - 56 mm.

Habitat. As its name implies, this frog lives in fairly dense, rather damp woods.

Breeding Habits. The eggs of this frog are laid some weeks before those of its relatives and consequently are sometimes frozen in the ice and killed. If the water stays very cold, the eggs may not hatch for weeks. If brought indoors the same eggs will hatch in four days. Although the eggs laid in March may be lost, there is usually another breeding period of the stragglers a few weeks later, so that most pools in the woods, fields, or even wooded river bays contain these frogs in the spring, as attested by the harsh, clacking croaks of the males, a sound resembling the noise made by dragging a shingle along a picket fence.


Common Tree Frog
Northern Wood Frog
Spotted Salamander
Newt
Larval Newt

The eggs are laid in masses attached to sticks and vegetation in 10 to 150 mm. of water. The whole frog colony of a pond usually lay together, often in a single warm night, so the egg clusters may be joined together in huge masses.

During the mating season the wood frog, never very shy, loses most of its timidity and emerges into the open. Its color blends so perfectly with wet, decaying leaves and bark that it is not taking the risk that one might think. When disturbed, the male swims along with his head just above the surface of the water, the female just under the surface. Both conceal themselves among the bottom debris if they are really frightened.

The tadpoles transform in May or June.

Food. The adult eats insects. In captivity it will eat mealworm larvae and worms very readily. The tadpoles are carnivorous, normally feeding on decaying animal matter. I feed them crushed snails or bits of chopped and washed raw liver, or dried shrimp in an emergency. Only a small amount is given at a time, to avoid polluting the water.

The wood frog is an ideal aquarium animal for many reasons. Like most frogs, it has pleasing colors. Unlike most frogs, this species tames readily and has an appetite that does not make impossible demands upon the mealworm cultures. Furthermore, it appears in early spring when one is usually in dire need of new aquarium material. If collected the first night of the spring chorus, it will breed in the aquarium and supply amateur biologists and biology classes with developing eggs. These eggs can be refrigerated for several days to prevent development, and then, when brought into the classroom, will develop under the eyes of delighted students.

If the adult frog is to be kept beyond the breeding season, at least one end of the aquarium should contain dry land, for this frog spends much of the year out of water.

Bullfrog *(Rana Catesbiana)*

Appearance. The Bullfrog is typically a large, blunt-nosed frog, usually light gray green, more rarely brownish green, above. The back is occasionally somewhat mottled with black and is covered with small warts. Beneath, it is yellowish white and usually faintly mottled with brown. The ear of the female is almost as large as her prominent eyes; that of the male is larger than the eye.

The tadpole is greenish brown above and spotted finely with black. It spends two winters as a tadpole and finally transforms in May of the third year, when some 150 mm. long.

Size. Adult size, 85 - 185 mm., or even longer when the frogs have not been hunted.

Habitat. The Bullfrog lives in large, shallow ponds and lakes. Except in the breeding season it tends to be solitary, each frog having a little cove of its own. It is strictly aquatic and seldom leaves the water for anything more than a sun bath.

Breeding Habits. The bullfrog is late in coming from hibernation and does not lay its eggs until late May or early June. At this time the frogs gather along one section of shore, and unless they have been hunted to the verge of extinction their full chorus is heard. It is started by one frog and picked up by first one and then another, until suddenly hundreds of voices roar out a measured diapason which proceeds for awhile, ends abruptly, and is then repeated. The sound, which somewhat resembles the roaring of a bull, can be written as "more rum" or "brr-wum." To imitate this sound the croaking should be bass and the r's rolled slightly with the soft palate.

The tadpoles are about 50 mm. long when they transform.

Food. The food of the Bullfrog is anything that he sees moving and can swallow. Small turtles, fish, frogs, snakes, young water birds, and insects are all grist for its large mill. It can even accomplish the seemingly impossible feat of swallowing a slightly smaller relative while both are being carried around in a sack. In captivity other frogs or minnows provide the necessary bulk. Needless to say, it is not an animal that one wants to support for long.

The voracious bullfrog proves to be an amusing pet for as long as one can support his great appetite. He can be retired to the goldfish pool if there is an excess of fish. There, as indoors, he will sing if stimulated by noises or even human singing.

Perhaps the potential owner should be warned that occasionally a Bullfrog when caught will emit a wild scream, like that of an injured child. This sound may make even a seasoned frog catcher let go, or, if heard echoing across a lonely marsh where some predacious bird has caught a victim, is calculated to send icy shivers down the spine.

Green Frog *(Rana clamitans)*

Appearance. The Green Frog is often confused with the Bullfrog. However, the snout is slightly narrower and the dark, greenish brown back has many dark brown spots and the head and shoulders are bright, grass green. The throat is yellow, the sides are marbled brown and white, and the belly and undersides of the legs are creamy white speckled with brown along the edges.

The tadpole is greenish brown above and has dark brown spots. The tail is of the same color as the ground color of the body, but the fins are spotted with brown.

Size. Adult length, 70 - 100 mm.

Habitat. This frog lives not only in the large shallow lakes which are the favorite resort of the bullfrog, but also in most other fresh waters.

Breeding Habits. It breeds in April or May but may come out of its underwater hibernation a month or so earlier. The eggs may be attached to plant stems but usually float at the surface of the

water. The eggs hatch in three to six days. The tadpoles transform sometime during the following summer, when about 30 mm. long.

Food. The Green Frog eats insects, worms, snails, and other frogs. It is not so voracious as its larger relative, but is nevertheless easier to keep outside where it can forage for itself. It probably pays little attention to fish and so is not a hazard to the pet goldfish.

This frog is more brightly colored than the bullfrog and more attractive to keep. It will continue laying in an aquarium if brought in during the breeding season and for this reason is particularly valuable in the classroom.

The green frog, too, will sometimes scream when caught.

Leopard Frog *(Rana pipiens)*

Appearance. The slender and agile Leopard Frog is the familiar spotted frog of low-lying fields and gardens. Its ground color is usually a light, bright green, but it may be brown, especially when it first appears in spring. On either side of its back is a ridge running most of its length. These two ridges are usually bronze during the summer but may be yellow during the brown phase. Between the ridges are two irregular rows of dark brown, round spots. The sides also have round spots, the smallest ones next to the belly. The upper surfaces of the legs are banded with brown. The underside of the frog is yellowish white and may be mottled with gray on throat, chest and legs.

This general pattern is subject to local and seasonal variations. Some frogs have more spots than others, and some have round spots, others oblong ones. Young frogs without spots are common in late summer.

The tadpole of this species is brown, flecked with gold above, iridescent bronze beneath. The tail is brown with black markings.

Size. The adult length is 52 - 102 mm.

Habitat. Swampy pools and ponds in the spring. During the summer it wanders into fields and open woodland. Like others of its genus, it hibernates in the mud bottoms of its breeding pools.

Breeding Habits. The eggs of this frog are laid during early

March in southern Michigan. They are usually fastened to plants in the weedy shallows.

The tadpoles emerge in about ten days. They transform in July when about 25 mm. long.

Food. The adult likes insects and worms. The tadpole lives on algae and decaying plant and animal matter.

This frog is one of the easiest to obtain and becomes quite tame. Although it has a modest appetite for a frog, it is well to keep only one or two, and those of equal size.

This frog may often be unearthed late in the winter by turning over small submerged rocks and logs and by raking the bottom of a likely pond. The unconscious specimen thus exposed should be brought home in cold water and allowed to warm up very slowly. Pairs obtained in this way will sometimes mate in the aquarium.

Pickerel Frog *(Rana palustris)*

This frog is very similar to the leopard frog, but has squarish spots, prefers cold springs and streams, and is more likely to be found close to water throughout the year.

Mink Frog *(Rana septentrionalis)*

This frog is a common inhabitant of lakes and rivers near the Canadian border. It is olive brown above, with large blotches of darker brown. When handled it emits the musky odor that gives it its name.

Its food is similar to that of the green frog.

THE TOADS
(Bufonidae)

These are the typical short, squat, heavy-bodied toads of the garden. Their skin is pebbled with warts and they have a heavy, swollen ridge of glands behind each eye. These are the paratoid glands which secrete most of the bitter juice that toads exude when bitten by a dog or other enemy. This juice is usually quite effective in discouraging further attack.

American Toad *(Bufo americanus)*

Appearance. Short, squat, heavy-bodied, warty toads, having a few warts, or a single one, in a spot. In contrast to Fowler's Toad, which has many smooth warts in a spot, the warts of this

toad often have horny tips. The vertical oval of the ear has a diameter only half that of the eye. The toes are broadly webbed, and the web is not deeply indented. The ground color varies, but is usually grayish or yellowish brown, with three or four pairs of brown spots on the back. Each of these spots contains but one large red or yellow wart. There is often a yellowish stripe along the backbone. The underside varies from pale yellowish white to orange-yellow, with blackish spots. The throat of the male is brownish orange.

The tadpole is round and black, flecked with gold. The long narrow tail has a narrow gray fin.

Size. Adult length, about 90 mm.

Habitat. Toads go to the pond when they come out of hiber-

nation in the spring. During the rest of the year they live in fields and gardens, where they eat many insect pests. The tadpoles metamorphose into tiny toads about 5 mm. long in late June or July. Thereafter they live on land.

Breeding Habits. The male comes out of hibernation about the middle of April and joins his fellows in some temporary pond or shallow bay. There he joins the chorus of nightly trilling—a bird-like song that carries far over the still night air. In a few days the females appear, and the first warm night thereafter the toads couple and each female lays two strands of eggs. Each strand is embedded in a clear glassy cylinder of gelatin which turns amber and opaque in a few days. The toads, having laid their eggs in a breeding area a few yards square, wander off to their dry land haunts. The eggs hatch in four or five days, and the tadpoles enter a life of independence from parental care.

Food. The adult eats almost anything around the garden that moves and that it can swallow—slugs, worms, crickets, ants, cutworms and most other insects. Someone has estimated that one toad is worth from five to twenty dollars to a farmer. The tadpole eats algae, meat, dead insects and the debris of the pond bottom. Mealworms are readily accepted by a captive toad. I feed this toad Pablum and minute quantities of scraped beef.

If it has an abundance of food, a mossy retreat, and a pool in which to refresh itself, a toad will live for years. It tames readily and when tame will stalk a mealworm before an audience.

Since toads eat a large quantity of mealworms it is best to keep one only over the winter. It will give good returns as a pet without requiring a battery of mealworms to support it.

Toads brought indoors when they first appear in the spring will lay their eggs in an aquarium, usually within twenty-four hours.

Fowler's Toad *(Bufo fowleri)*

Fowler's Toad is a somewhat paler and more agile counterpart of the American Toad. In Michigan it is found chiefly along the beaches and in the vicinity of Lake Michigan.

THE TREE FROGS
(Hylidae)

The tree frogs are essentially froglike in appearance, but their skin is pebbled with tiny warts and they have sticky disks on the end of their toes. Only a few are truly aquatic. All are interesting, but only the common tree frog (*Hyla versicolor versicolor*) becomes really tame in captivity. As a pet it is as satisfactory as a toad, and more interesting, since it can change color.

Meadow Cricket Frog *(Acris crepitans)*

Appearance. This little tree frog looks like a miniature true frog. Its ground color varies from dark through reddish brown to greenish. There are three oblique blotches of a darker shade on either side. The legs are striped above. Beneath, the frog is yellowish white with dark mottlings on the throat and dark spots on the chest and legs.

The tadpole is blackish olive, with speckled, transparent tail fins. The tail is tipped with black.

Size. Adult length, 15 - 33 mm.

Habitat. Wet meadows, and particularly along the shores of muddy ponds.

Breeding Habits. The brown and white eggs are laid any time from May on through the summer. They are usually deposited singly on the stems of grass in very shallow water. Each frog lays about 250. The tadpoles transform when about 12 mm. long.

Food. Small insects.

This little frog can be recognized best by its rapid, metallic, cricketlike call, heard along pond shores in the spring and again in the fall.

The cricket frog is so inconspicuous and so shy that it is seldom seen by any but the most observant. When approached it dives into the water and quickly buries itself in the silt. In captivity it is quite shy but may be kept for many weeks if there is an adequate supply of small mealworms to feed it.

Swamp Cricket Frog
(Pseudacris nigrita triseriata)

Appearance. A small, slender frog with a pointed nose and a definitely three striped appearance. The ground color of the back is grayish to brown. The stripes are dark brown. The middle one is often broken. The upper surfaces of the legs are spotted. Underneath, it is cream or silvery white. The skin is finely granular.

The tadpole is black with bronze in the belly and sides. It transforms in June when about 9 mm. long.

Size. 21 - 37 mm. long.

Habitat. In and around low bushes beside ditches and ponds. I find them chiefly beside pools in the woods.

Breeding Habits. The eggs are deposited on the stems of shallow water plants in irregular clusters about 25 mm. in diameter in May. There are 20 to 100 eggs in a cluster. A female lays upward of 500 in all. The eggs are black and white.

Food. Small insects.

This species is essentially like the preceding one.

SPRING PEEPER *(Hyla crucifer)*

Appearance. A small frog with an *X* on its back. Less striking markings are a dark *V* between the eyes and narrow dark bars on the upper surface of the legs. The ground color may vary from

dark liver brown to light brown. Beneath, the color is reddish cinnamon, except in the male, which is bright yellow at the throat and groin. The color of a captured specimen usually fades, at least temporarily, to a pale fawn color.

Size. Adult length, 18 - 33 mm.

Habitat. Any open pond, water hole or marshy place in the spring; in damp woods and orchards in the summer.

Breeding Habits. The eggs are laid singly, often in rows, along the stems of shallow water vegetation in April. They are cream and brown to black. The tadpole hatches in about ten days, and transforms during the summer when about 12 mm. long.

Food. Small insects. Very young mealworms are good for captive specimens.

The spring peepers are best identified in spring by their shrill call of "pee-eep; pee-eep, pee-eep." The noise is remarkably loud —so loud that if one stands quietly in the middle of a pond until the chorus is resumed, the noise is painfully loud, and the eardrums can be felt vibrating in sympathy with the measured beat. When the call is given the throat of the male is large and translucent.

This species is shy and hides readily, and careful stalking and a period of silent waiting are necessary before a spring peeper can be caught during the daylight hours. Early in the spring males will continue to sing indoors.

Common Tree Toad
(Hyla versicolor versicolor)

Appearance. A typical tree toad is frog shaped and pebble skinned, has conspicuous adhesive disks on its toes, and blends in color with any background upon which it is found. The blending is so perfect that in order to photograph a tree toad I place him on a background of contrasting color and quickly snap the picture before he can match his surroundings. The ground color on the back may vary from medium brown through green to ash gray. There is a blackish brown, irregular star on the back and green bars edged with black on the tops of the legs and under each eye. Un-

derneath it is silvery except on the underside of the hind legs, which is orange.

The tadpole is greenish, spotted with black and gold above and iridescent pinkish gold beneath. The spotted upper fin of the tail is wide and extends almost to the head. The muscular part of the tail is vermilion, spotted with black.

Size. Adult length, 50 - 60 mm.

Habitat. The tree toad loves old trees and fences covered with moss or lichen. During the spring it goes to shallow, more or less temporary ponds and even artificial pools, where its loud, resonant trills can be heard at night and on cloudy days. It hibernates in hollow trees or among the roots of some large tree.

Breeding Habits. The tree toads migrate to their breeding pools early in May. Here they give their mating song, which consists of

a rapid series of trills. Each female lays about 1000 eggs sometime during the spring or summer. The brown and cream or yellow eggs are laid in scattered masses of four to forty. Hatching takes place in four or five days. The tadpoles transform sometime during the summer, when 13 to 20 mm. long.

Food. It eats many sorts of insects and their larvae. In captivity flies and beetle larvae are readily accepted.

Tree toads collected in the spring when first heard singing may mate and lay their eggs in an aquarium containing a few mossy branches and a pan of water. At least, they will sing and eat for you.

If kept for some time a tree toad should be given the run of a large aquarium or conservatory. In a conservatory it will repay its host by eating cave crickets, earthworms, and other pests of potted plants. A bowl of mealworms should be provided at all times to satisfy a not inconsiderable appetite.

Native Reptiles

Reptiles may be defined as cold-blooded (their blood temperature changes with air temperature), backboned animals which breathe by means of lungs and are usually covered by scales or body plates. This group includes the snakes, lizards, and turtles. One Michigan species, the Soft Shelled Turtle (*Amyda spinifer*), lacks a covering of scales or bony plates.

In form, the snake is a long cylinder which tapers toward the tail end. In our species there is not even a suggestion of limbs.

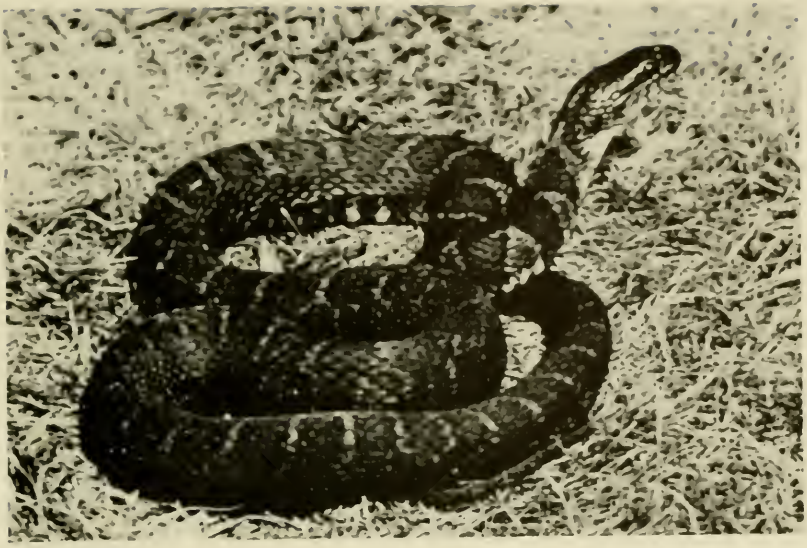
Lizards have tapering bodies, usually not so long in proportion as in the snakes, and ordinarily have four legs. However, certain legless forms exist. They are often confused with salamanders, but can be readily distinguished from them because they do not have the scaleless, moist skins of the salamanders, and since they are often found lying in the sun their scaly skins feel dry and relatively warm.

Turtles have a more or less bony shell forming a roof over their backs and are well known to everyone.

SNAKES

The true water snakes are found in or near the water and when full grown are mud brown. They are often called "moccasins" and considered poisonous by those who know nothing about snakes. Since they are quite savage when held and will bite to the best of their ability, they themselves seem to enjoy this reputation. Actually, they are not at all poisonous and can inflict no more than a few surface scratches. However, it is well to disinfect wounds made by them.

Although the garter snakes are not generally known to be aquatic in habit, they are quite as much so as many of the frogs. The Common Garter Snake, the Ribbon Snake, and Butler's Garter Snake are increasingly aquatic in the order given, the last being found living under the same conditions as the true water snakes (*Natrix*).



Common Water Snake
(Natrix sipedon sipedon)

Appearance. Among our local snakes this species is the most heavy-bodied. It is rather long but is matched here by the decidedly non-aquatic Fox, Blue Racer, and Pilot Black Snake. An old specimen, especially just before shedding its skin, exhibits little color pattern but appears bluish black or dark reddish brown. Younger snakes have a light brown ground color with cross bands or squarish, red brown spots across the back and sides. In a medium-sized specimen and in the posterior third of an older snake, the dark spots are in definite rows, one row of large spots down the middle of the back and one row of much smaller spots down each side. These spots on the sides are opposite the narrow, light spacing of the spots on the back, but overlap the dorsal spots. These dark spots are usually edged with darker brown. The underside is white or yellow with numerous red or brown half moons across it. The underside of the tail is quite dark.

Very young snakes have black markings which lighten during the second year.

Size. The adults are about 1060 mm. long.

Habitat. This water snake lives along the water anywhere, whether it be a hole dug for stock, a stream, a pond, or one of the Great Lakes.

Breeding Habits. As far as I have observed, this water snake mates in the spring. The eggs develop and hatch within the female. She gives birth to about twenty-four young during the late summer or early fall.

Food. This species, like the Bullfrog, eats anything that it sees move and that it can swallow, including crayfish, frogs and fishes. Of this assortment, fishes seem to be the favorite food. In spite of the worries of fishermen, this snake has little chance of catching uninjured fishes of game species, except under the artificially crowded conditions in hatchery pools.

The Common Water Snake is too large to be a desirable aquarium specimen when full grown, but is interesting when small. It is called a "water moccasin" by country people, but it lacks poisonous fangs and is harmless. It will bite readily when first caught, and its little curved teeth may even draw blood just as those of the Blue Racers do. However, it soon becomes accustomed to handling and becomes rather tame.

In an aquarium equipped with an island or log this snake will live happily on minnows and frogs. As it is a good climber the tank should be covered.

Queen Snake *(Natrix septemvittata)*

Two other Michigan water snakes, the Queen Snake (*Natrix septemvittata*) and Kirtland's Water Snake (*Natrix kirtlandii*) have many of the characteristics of the Common Water Snake, but are much less commonly encountered. The Queen Snake is chestnut brown above with three narrow black stripes along the back and a yellow stripe along each side. There are two dark brown stripes along the center of the yellow belly and a dark stripe beneath the two yellow side bands. It grows to be 600 mm. long.

Common Garter Snake
(Thamnophis sirtalis sirtalis)

Appearance. A medium-sized snake with three yellowish or greenish stripes on a ground color which may be brown, light green, olive, or black. The stripes on the sides are on the second and third rows of scales above the large scales of the belly. Usually there are two rows of black spots between the stripes. The belly is greenish white or yellow with black blotches along the edges.

Size. A large adult may reach 900 mm. in length.

Habitat. This species is commonly found in thickets near water.

Food. Earthworms, frogs, toads, salamanders, tadpoles and occasionally fish.

Ribbon Snake (*Thamnophis sauritus*)

Appearance. The Ribbon Snake is exceedingly slender and has a vivid yellow stripe down the middle of the back and another along each side on the third and fourth row of scales above the belly scales. The middle stripe usually has a tinge of orange, the side stripes a tinge of green. Below the stripes on either side is a broad band of chestnut brown. There is no checkerboard pattern of square dark spots between the stripes in this species. The rich dark

brown or black ground color is unmarked. The belly is pale green and usually unspotted.

The tail usually constitutes more than a fourth of the body length.

Size. An extremely large specimen may reach 650 mm. in length.

Habitat. This species seems to be particularly fond of the shores of ponds and streams in moist woods. Like the Common Water Snake, it will take to the water if disturbed. It may remain under water for a few minutes, but seems to swim under water less than the Water Snake. Although it does not live out in open marshes like the Water Snake, it often climbs up in button bushes growing in the water. It is generally considered an aquatic snake.

Breeding Habits. This species, like most others, mates immediately after coming out of hibernation in the spring. The mating male slides over the female, rubbing his skin against her back, thus

arousing his ardor by rubbing the sensitive areas on his chin. Sometimes many males court one female until one is successful in coupling with her. The twelve or so young are born late in the summer.

Food. This species feeds on insects, salamanders, tadpoles, frogs, toads and fish. Unlike most of its immediate relatives, it seems to dislike earthworms.

The Ribbon Snake is of a convenient size to keep in an aquarium. It is more attractive and not so voracious as the Water Snake. Like the latter, it will eat small fishes readily and when tame can be taught to eat bits of large fish. Thus it is an easy snake to keep in condition.

A basking place, preferably quite dry, should be provided. Every effort should be made to keep the water clean to avoid infecting the snake with mouth-rot and similar snake ailments.

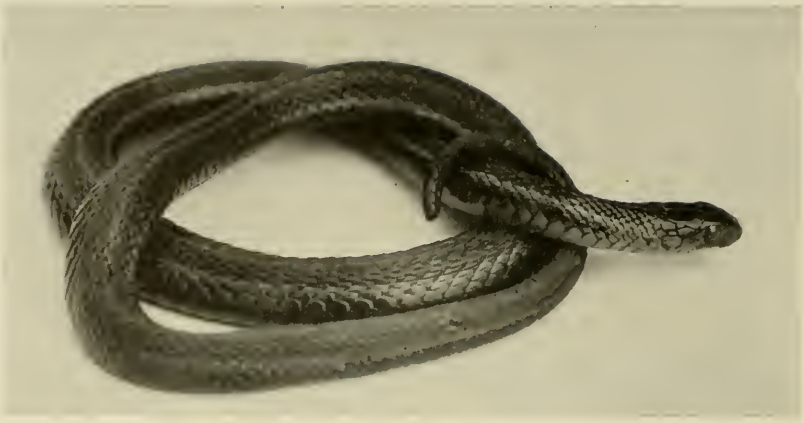
Butler's Garter Snake *(Thamnophis butleri)*

Appearance. This snake is thick, short-bodied, and clumsy. It tapers forward to a thin neck and narrow head. The tail is usually less than a quarter of the length of the body. There are three distinct yellow stripes down the back, varying in color from lemon to greenish yellow. The ground color is chocolate, black, or dark olive. Beneath the lateral stripe there is a band of the ground color. Along the back, between and partly overlapping the stripes, there may be two rows of black spots on the skin. Often these join irregularly or blend in dark specimens and consequently disappear. The belly is greenish white, with black spots along either edge of some of the plates.

The tail is less than a fourth of the body length.

Size. The adult length does not usually exceed 450 mm.

Habitat. This garter snake always lives in swampy places or at the edge of some stream or pond. It is quite shy and commonly hides under boards and logs when not hunting. In comparison with the Ribbon Snake it appears very clumsy in the water, for it tries to progress by stretching movements. It is even more awkward on land. This unfortunate species is so clumsy that it is forced to



spend much of its time in hiding, for it cannot rely upon agility to escape its enemies.

Breeding Habits. Like its relatives, this species breeds immediately after hibernation. The female gives birth to her twelve to fifteen young three and one half to five months later. A female has been seen eating earthworms between the births of her young.

Food. A young specimen will eat earthworms, leeches, or small minnows if they are placed in a pan of shallow water. When larger it will eat living frogs. It is so fond of fish that it will eat it avidly whether dead or alive.

The sluggishness and clumsiness of this species perhaps make it a more suitable one to keep captive. Its readiness to eat and to take dead fish and bits of fish is certainly a recommendation for it in captivity.

The aquarium should be supplied with an island, preferably mossy, and containing a few flat stones. A snake will retreat under the moss or stones when it finishes eating. It should come out in the open to eat after only a few days of captivity.

The small size and attractive colors of this aquatic snake are further recommendation.

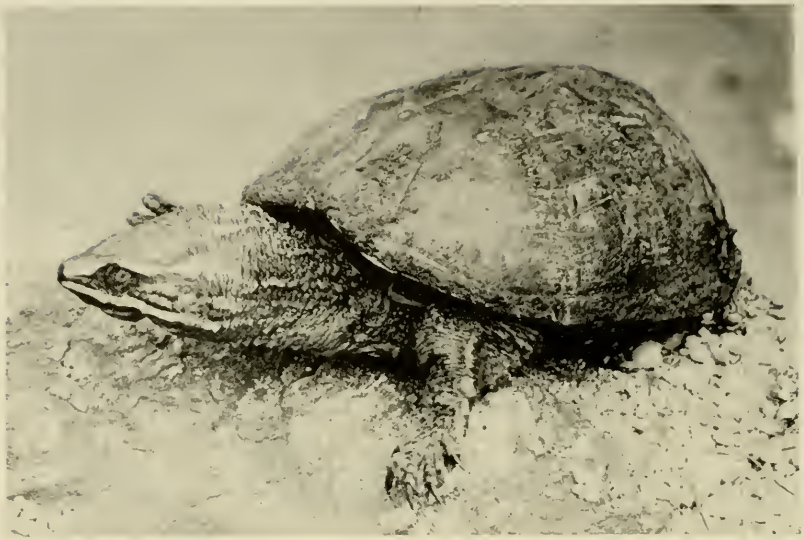
TURTLES

Most of our Michigan aquatic reptiles are turtles. Many of our turtles feed entirely in the water and go away from it only to lay their eggs. Many come out far enough to sun themselves, but even they pick a site on some floating log where a few steps will enable them to plunge back into their protecting element.

The shell of the turtles is a unique and typical feature of their anatomy. The back is protected by a series of fused bony plates (called the carapace) rigidly attached to the backbone and curved to form a protecting box. The underside of a turtle is protected by a rather flat shield (called the plastron) which is also composed of flat plates of bone fused together. The plastron is joined to the carapace at either side between the front and hind legs. When a turtle is on the defensive, he pulls his head and forelegs back through the front hole in his armor and his tail and hind legs in through the rear opening. His feet, tail and head are protected by heavy skin and scales which serve to guard the holes. In the case of two species which are terrestrial, Blanding's Turtle and the Box Turtle, the plastron is hinged and can close so tightly as to protect the entire body beneath a bony shield. The Musk Turtle also has a hinged plastron but cannot effectively close up his shell. However, in the late summer all these turtles are so fat that the doors of their shells cannot close.

The heads of turtles are armed with more or less highly developed bony ridges which enable them to give a powerful cutting bite. The toenails are well developed and sometimes very long. Those of the forelegs are used to hold food and, in the case of the Painted Turtle, in courtship.

In captivity turtles will sometimes develop fungus around the eyes or mouth or in wounds. For treatment see Appendix 3. This fungus often results from the water's being polluted or from a lack of provision for the turtles to dry and sun themselves. One end of the aquarium, not just a stone island, should be built up so that there is some dry land. A sloping landing place of rough stone or wood should run from the land down into the water.



THE MUSK TURTLES
(Kinosternidae)

There is but one species of this family recorded for Michigan.

Musk Turtle *(Sternotherus odoratus)*

Appearance. The Musk Turtle is our smallest turtle. It is distinguished chiefly by having a highly domed upper shell, usually covered by a growth of algae, by its very pointed nose, and by its penetratingly pungent odor. The two yellow stripes at either side of its head are the only conspicuous markings. The shell is olive brown and may be somewhat spotted or streaked.

The young Musk Turtle has a rough upper shell which is almost as wide as it is long and has a distinct central ridge with a ridge on either side of it. The roughness and the lateral ridge, and often even the central one, disappear with age.

Size. About 120 mm. long.

Habitat. Mud-bottomed ponds, rivers, and pools in streams and bays of the Great Lakes are typical locations for this species.

Breeding Habits. Mating in this species may take place in fall or spring. Spring mating seems most frequent. The male pursues the female for some time but there is no complex courtship.

The female deposits her eggs during June or early July. They are laid in a variety of places, but old muskrat lodges, rotten stumps, and the soil beneath a fallen log are common locations. Often a number of females will lay on the same muskrat house. Occasionally eggs are deposited in the open, where, owing to their thick shell, they may complete development.

Food. Almost anything of living origin may be eaten by the Musk Turtle. It prefers flesh, such as fish and tadpoles, but will eat refuse and decaying water plants.

Although plain in appearance, this species is easily kept in an aquarium. It is almost wholly aquatic and can get along without sunning itself; in fact, the adults probably do not sun themselves out of the water at all. Because of its pugnacity it is easy to get a new specimen to eat in captivity by tapping its snout with a piece of meat. Incidentally, the Musk Turtle prefers to do its eating under water.

THE SNAPPING TURTLES
(Chelydridae)

This family includes but two North American forms—the Alligator Snapper of the southern United States and the Snapping Turtle. Both are large, horny-shelled, pugnacious turtles, with a large crest of plates along the tail.

Snapping Turtle *(Chelydra serpentina)*

Appearance. The Snapping Turtle is our largest and most pugnacious turtle—and the one most commonly eaten by man. Its heavy upper shell has three longitudinal ridges. In a young turtle the scales are very rough and the ridges prominent, but they become increasingly smooth with age. However, the posterior toothing of the upper shell and the prominent projecting plates on the top of

the long tail persist. The lower shell is diamond shaped and very small in proportion, and the soft folds of the underside of the turtle are thus little protected. Perhaps this lack explains the bad temper of this animal, which evidently considers offense the best defense.

The color of the upper shell varies from black through dark olive to brown, and is often much obscured by growth of algae. I have stepped upon a partly submerged snapper mistaking it for a mossy stepping stone in a brook.

Baby Snapper

The yellow lower shell is surrounded by gray folds of skin.

The dark brown head is large and armed with heavy, bony jaws which are hooked at the end.

Size. An average-sized female from this area has a shell 275 mm. long and 238 mm. wide. Occasionally much larger turtles are found.

Habitat. This species is to found in any body of water large enough to harbor animals upon which it can feed. Not even formal garden and fish hatchery ponds escape damaging visits.

Hibernating individuals are reported from muddy ponds.

Breeding Habits. Mating evidently can take place at any time from April to October. The male grasps the female by hooking the claws of all four legs under the edge of her upper shell. His long tail is then curled around and under hers so that their vents are in contact.

The female comes out in the early morning during the first part

of June to lay her eggs. She may wander a great distance in search of a place to make her nest, in spite of the fact that the choice of sites of snapping turtles varies from the wet, spongy top of an old muskrat lodge to the barely damp, sandy soil of an upland pasture.

The nests vary as greatly in shape as in types of location. One of more elaborate construction is dug by alternate strokes of the hind feet and is somewhat flask-shaped in construction. The bottom is about one foot wide and three or four inches from the surface. Some twenty to forty eggs are laid in the nest, and then dirt and other debris are scraped into and over the hole by the hind feet of the female.

The eggs apparently hatch the following spring in Michigan, but further south hatch in August of the year laid.

A nest containing some fifteen eggs was ploughed up in an old field near Metamora, Michigan in November, 1940. The location was about 500 feet from a trout stream (which also contains pike and minnows), and about ten feet above stream level. The soil is sandy. The eggs were placed on a mantle at room temperature (about 72° F.) and there hatched during the following two days. The turtles were then brought to me. At this time all had some remnants of yolk sac attached, some with yolk sac two to six mm. long.

In the laboratory the little turtles proved to be rather sluggish. However, in a brightly lighted room they consistently crawled toward the large, brightly lighted windows at one end of the room, regardless of whether they had to crawl up or down an improvised hill. In the absence of light they buried themselves in moist sand. On December 2, they were placed in a one-quart fruit basket with a small Painted Turtle, covered with moist sand, and buried in a coldframe outdoors. There they remained until May 5, 1941, when they were remembered and excavated. At that time only one snapping turtle survived, but it seemed to be in good condition and was released. When allowed to crawl on the warm ground, the survivor persisted in crawling downhill if left to itself. If placed in the shade, it crawled into the open and then started

downhill. In this case downhill led to some ponds only a few hundred feet away. Whether gravity, scent, or something that may be called instinct, for want of better knowledge, led it in that direction cannot be stated.

Food. The young turtles eat aquatic insects, especially the soft larvae, snails, and tadpoles. As the turtle grows the diet is extended to include frogs, fish, salamanders, reptiles, and even birds and mammals. We estimated a minimum loss to turtles of 110 young mallard ducklings on our lake one season.

This turtle is characterized by its aggressive disposition and musky pond-bottom odor, and by being a walking incubator of parasites, from the clustering leeches on its soft outer parts to the trematode, cestode, and nematode worms in its digestive tract. Since a large snapper is genuinely dangerous only small specimens should be kept as pets. In the aquarium a small Snapping Turtle will thrive on any diet that includes animal matter. It will especially appreciate any living fishes that you may place with it.

Be sure not to allow the water containing one of these animals to become polluted by decaying food.

THE TERRAPINS
(Testudinidae)

These turtles are distinguished by having a broad, flattened carapace, which is usually smooth. Their hind toes are well webbed and they are excellent swimmers, although some species may spend part of the time feeding on land. Many have long claws on all four feet, the front claws of the males being very long. They are to be found in or near rivers, streams, lakes, and even salt marshes. A brackish water species, the Diamondback Terrapin, is America's most noted and expensive food turtle.

Spotted Turtle *(Clemmys guttata)*

Appearance. The upper shell of this species is black, occasionally tinged with red. There are round orange spots on each scale—one to a scale in young turtles, often two or more in older ones. The

upper shell is smooth, flattened, unindented at the edges, oval in outline, and widest behind the middle.

The lower shell is large in proportion, has no hinge, and is fastened rigidly to the upper shell. Its scales are all black if the turtle is very young, but increasingly light yellow toward the middle in an older animal. The shell of the male is concave, that of the female somewhat convex or else flat, and more nearly reaching to the posterior edge of the upper shell than in the male.

There are certain differences between the heads of the two sexes. The head of the male is larger and is black, including the bony portion of the jaws. Usually there is no yellow stripe on the lower jaw. The eyes are dark brown, and the black throat is finely speckled with orange. The head of the female is somewhat smaller, and the horny portion of the jaws is light yellow. In addition, there is a bright yellow stripe along the lower jaw. The eyes are bright orange, and the throat is streaked and spotted with yellow.

Size. Maximum length of upper shell about 115 mm., width 86 mm.

Habitat. This species prefers ponds and streams that have mud bottoms and an abundance of vegetation.

Hibernating individuals are reported from the underwater mud of ponds and a spring.

Breeding Habits. Mating occurs in early May, after the male has pursued the female for some time. It may occur on land or in the water.

The eggs are laid toward dusk late in June. The female digs a flask-shaped depression near the water and deposits about three eggs. She then covers them so well that the nest is hard to detect. Under artificial conditions eggs have hatched in 82 days. An egg measures some 22 by 16 mm.

Food. Insect larvae, and occasionally insects; snails, crustaceans, tadpoles, and especially frogs and carrion, seem to be favorite foods. In captivity it will eat lettuce. The Spotted Turtle seems to prefer to eat with its head under water.

The Spotted Turtle makes a gentle, attractive and ideal pet. It eats readily in captivity and is not too fussy. An aquarium equipped with a sunning ledge suits it very well. In all kindness, a turtle caught in the spring should be relased soon enough to store food and sunshine in preparation for the winter hibernation.

Map Turtle *(Graptemys geographica)*

Appearance. The upper shell of this turtle is quite smooth in an adult. It is widest just back of the middle and is bluntly pointed behind. There is a slight but distinct ridge along the backbone. The color of the shell is dark olive or brown overlaid with a fine network of greenish yellow lines. The lines are conspicuous in a young turtle, but in an old one may show only when the shell is wet. However, the head, neck, tail and legs have narrow longitudinal yellow markings on a blackish olive ground, and there is also a triangular yellow patch above and behind each eye. Each of the yellow scales on the underside of the edge of the upper shell has whorls of olive green lines which resemble coarse finger prints.

The lower shell is plain yellow except for some olive stripes at the edge of the juncture of the upper and lower shells.

Size. The upper shell of a large female measures about 240 to 285 mm. The male is about two thirds as long as the female.

Habitat. This species normally inhabits the bays and marshes of large rivers, lakes, and ponds. It avoids flowing water, clean bottoms, and small ponds.

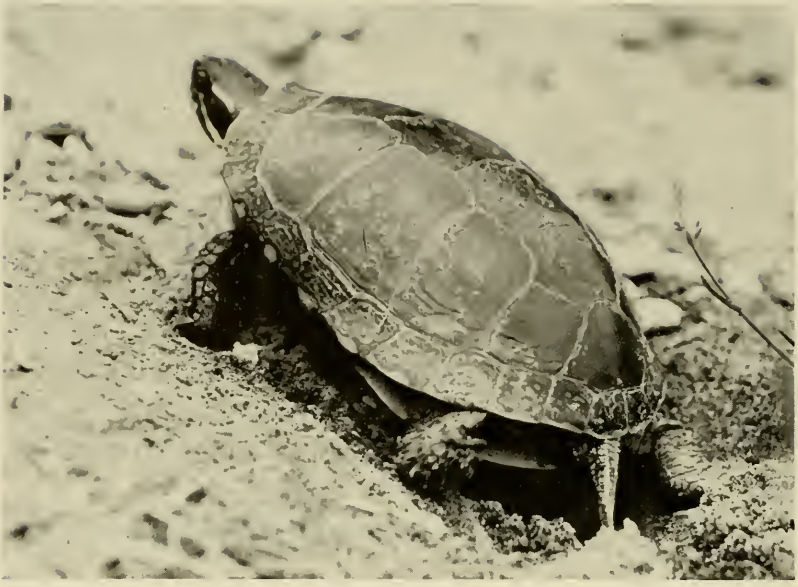
Breeding Habits. This species is said to mate late in April. The eggs are laid chiefly in June, but occasionally much later. Hatching may occur in August, September, or May, probably depending upon where the eggs are laid.

The female constructs a flask-shaped hole in some field, often at a considerable distance from the water. From ten to sixteen eggs are said to be laid at one time.

Food. The natural food of this species seems to be chiefly snails and clams, both of which are fairly readily crushed by its heavy jaws. In captivity these turtles are extremely reluctant to eat, even when placed in large pools. Ditmars reports that they never survived a winter in the pond of the New York Zoological Gardens and surmises some dietary deficiency.

Although this species is decidedly aquatic, its shyness and unwillingness to eat in captivity make it unsuitable for prolonged aquarium use.

It is this species that forms the amusing rows and even piles of sunning turtles along the edge of large lakes.



Digging for egg laying

Painted Turtle *(Chrysemys picta)*

Appearance. The upper shell of this species is flat and smooth, and is widest near the posterior end and smoothly rounded behind. In color it is a dark reddish brown or dark olive. The scales have a more or less evident border of yellow. The scales along the upper and lower edge of the upper shell have blood-red lines or blotches. The brown head has four yellow spots, one behind each eye and the other pair at the back. The underside of the head and neck are liberally streaked with bright yellow. The lower shell is bright yellow except for a rectangular blotch in the middle. This blotch is made up of many parallel fine lines, often blurred together. There are lines of red on the legs and tail.

The claws on the front feet of the male are two or three times as long as those on the hind feet.

Size. The average length of the female is said to be about 142 mm.; of the male, about 118 mm.

Habitat. This species rather consistently inhabits smaller bodies of water than the Map Turtle, which often looks the same at a distance. The Painted Turtle prefers small bays of large lakes, small ponds, pools in small streams and rivers, and even drainage ditches —wherever vegetation is abundant.

Breeding Habits. Mating apparently may occur from spring to autumn. Less is known about it than about the interesting courtship. During courtship the male swims after a female and passes her, then whirls around and swims backward, facing her as she swims. Upon being overtaken by the female he thrusts out his forefeet with their backs together and briefly vibrates the claws against the chin of the female. He then withdraws his feet, swims backward in front of her for five or ten seconds, then chucks her under the chin again in his seductive way.

The eggs are usually laid during June or July. The nesting site is anywhere that fancy dictates, sometimes within a few feet of the shore, sometimes even in hard ground hundreds of yards away. The female digs a nest, using her hind feet much as a human being might use his bare hands. It is reported that hard ground is softened by occasional emissions of urine until it can be scraped away. When a satisfactory flask-shaped hole has been dug some six to fifteen eggs are laid. In size they are about 20 by 31 mm. The female then covers them very cleverly, even packing down the earth with her knuckles and dragging herself over the site.

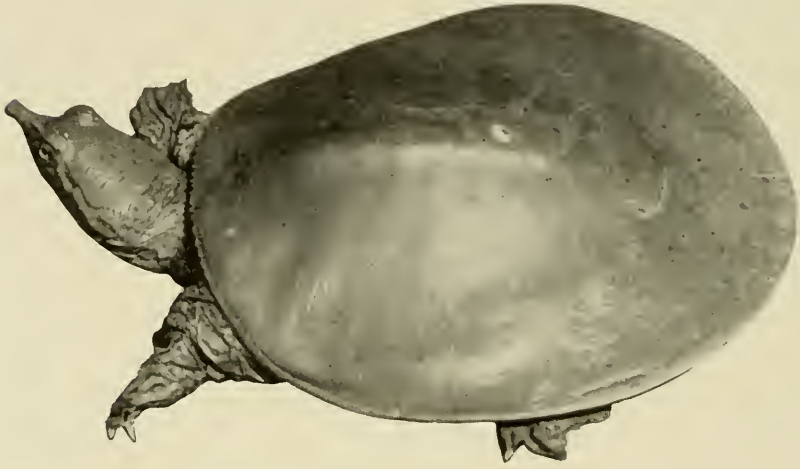
The usual time of hatching is September, but apparently the eggs in some nests do not hatch until the following spring.

Food. Painted Turtles seem to feed chiefly on flowering plants and algae. Insects, carrion, and occasional mollusks are also eaten.

The Painted Turtle tames readily, eats freely of such foods as are at the aquarist's hand, and is reasonably hardy. Since it is also attractively colored it leads the list of desirable aquarium animals. A small specimen is preferable. The aquarium should contain a projecting rock upon which the turtle can sun itself.

THE SOFT-SHELLED TURTLES
(Trionychidae)

The turtles of this group cannot be mistaken for those of any other family. The upper and lower coverings (carapace and plastron) have the consistency of wet leather and cannot be called shell. The neck is very long, and the head is narrow and terminates in a slender snout. Keen jaws, which can cut through flesh as readily as those of a Snapping Turtle, are concealed by thin fleshy folds of skin. The broad feet are widely webbed.



Soft-shelled Turtle *(Amyda spinifera)*

Appearance. The leatherlike upper surface of this species has a row of spiny bumps along its front edge. The color of the "shell" is olive or light brown with a broken black line near the margin. A young specimen is a light bright green with numerous brown spots, each encircled with a black line, scattered over its back. Toward the edge these spots become smaller and darker until the outer ones are black dots. The edge of the "shell" of the young turtle is yellow; the lower "shell" is white and fails to cover the posterior part of the body.

The head of an adult is olive green. On each side of the head and

neck there is a yellow stripe with a black edge. These stripes pass through the eyes and along the narrow snout and unite just behind the nostrils, each of which is divided in two by a thin partition. Neck, legs and tail are speckled and blotched with black.

Although the webbed feet and heavy legs look clumsy, this species is a fast and graceful swimmer and can move quickly on land.

Size. A medium-sized female is some 315 mm. long by 246 mm. wide. The male is appreciably smaller.

Habitat. Shallow, quiet rivers, streams, and inland lakes seem to be preferred habitats. Dense vegetation is not desired by this active swimmer, but a mud bottom is used for concealment. Where it can, this species likes to sun itself on grassy banks or beaches. Lacking such opportunity, it prefers shallow, warm bays.

Breeding Habits. Little is known of the mating of this species, probably because of its extreme wariness. The eggs are laid in late June and July. The female warily leaves the water, long neck upstretched and eyes alert. If the coast is clear she digs a typically shaped nest about 150 mm. deep with her hind feet, lays her twelve or so eggs, and packs on top of them sand moistened with urine. Once the sand is neatly packed down she returns to the water without a backward glance.

The spherical white eggs are about 29 mm. in diameter.

Food. Crayfishes appear to be the favorite food of this species, but aquatic insects, mollusks, earthworms, frogs, tadpoles and fish are also eaten. It is said that their food is mostly swallowed whole, but they can clip large pieces out of a piece of fish or beef.

The young Soft-shelled Turtle makes a good pet. It soon becomes tame and eats readily. Although it is thoroughly aquatic it will appreciate a sloping wooden platform upon which it can sun itself. Platforms of stone or even sand scratch its tender underparts and eventually cause fatal sores. It must be protected from larger specimens of other species such as the Painted or Musk Turtles, for they will bite pieces out of it.

Old specimens are too large and aggressive for an aquarium and are considered much more attractive in the soup kettle.

APPENDIX 1

Hardy Exotic Fishes

All things considered, the fishes coming under this heading will prove better suited to the aquarium than freshly caught native fishes. In the first place, they are the pick of the fishes of the world in hardiness as well as beauty. In the second place, almost all exotic fishes on the market have been aquarium raised for generations and so have become aquarium-hardy by a process of selection. Furthermore, these preferred species will not disturb the plants which are essential to keeping an aquarium in a state of biological balance.

Since obviously fish obtained from a pet shop have been handled, it is well to quarantine all of them for a week after purchasing them. They should be placed in a clean aquarium well planted in at least one end. During the quarantine period the water in the tank should be treated with three drops of 2 per cent mercurochrome per gallon of water (231 cubic inches), and the temperature should remain at 75°-80° F. They should be fed regularly during this period. At the end of the period of quarantine, the water should be siphoned off and replaced with water from another aquarium or water which has been standing, preferably with plants in it, for several days. The aquarist refers to this as "aged water" and seldom considers using any other unless it comes from a clean lake or stream. It is important that all water removed from an aquarium should be replaced by water of the same temperature.

Once new fish have passed through their period of quarantine and have proved to be in good health, they may be placed with other fish. It is best to add several to a tank, for sometimes the original inhabitants will decide to drive off a single intruder.

HARDY EXOTIC FISHES

The Characins (Characidae)

Copeina—(*Copeina guttata*) 75-100 mm.
Tet from Rio—(*Hyphessobrycon flammeus*) 40 mm.
One-line Tet—(*Hemigrammus unilineatus*) 50 mm.
Riddlei—(*Pristella riddlei*) 45 mm.

Bloodfin—(*Aphyocharax rubripinnis*) 45 mm.
Black-winged Hatchet Fish—(*Carnegiella marthae*) 32 mm.
Neon Tetra—(*Hyphessobrycon innesi*) 32 mm.

The Minnows (Cyprinidae)

*Giant Danio—(*Danio malabaricus*) 100 mm.
Zebra Danio—(*Brachydanio rerio*) 45 mm.
Pearl Danio—(*Brachydanio albolineatus*) 65 mm.
Rasbora—(*Rasbora heteromorpha*) 45 mm.
Flying Barb—(*Esomus danricus*) 100 mm.
Rosy Barb—(*Barbus conchonius*) 90 mm.
Clown Barb—(*Barbus everetti*) 125 mm.

The Loaches (Cobitidae)

Spotted Weatherfish—(*Cobitis taenia*) 100 mm.
*Japanese Weatherfish—(*Misgurnus anguillicaudatus*) 205 mm.

The Smooth-armored Catfishes (Callichthyidae)

Corydoras—(*Corydoras paleatus*) 70 mm.

The Egg-laying Tooth Carps (Cyprinodontidae)

Brown Rivulus—(*Rivulus cylindraceus*) 55 mm.
Medaka—(*Aplocheilus latipes*) 50 mm.
Florida Flag Fish—(*Jordanella floridae*) 50 mm.

The Live-bearing Tooth Carps (Poeciliidae)

Mosquito Fish—(*Gambusia affinis*) 55 mm.
Dwarf Mosquito Fish—(*Heterandria formosa*) 35 mm.
Blue Limia—(*Limia tricolor*) 65 mm.
Guppy—(*Lebistes reticulatus*) 55 mm.
Moonfish—(*Platypoecilus maculatus*) 50 mm.
Variatus—(*Platypoecilus variatus*) 50 mm.
Mexican Swordtail—(*Xiphophorus helleri*) 70 mm.

The Labyrinth Fishes (Anabantidae)

*Paradise Fish—(*Macropodus opercularis*) 75 mm.
Dayi—(*Macropodus cupanus dayi*) sometimes called *Polycanthus dayi*. 70 mm.
Dwarf Gourami—(*Colisa lalia*) 50 mm.
*Striped Gourami—(*Colisa fasciata*) 115 mm.
Three-spot Gourami—(*Trichogaster trichopterus*) 125 mm.
Pearl Gourami—(*Trichogaster leeri*) 100 mm.

The Cichlids (Cichlidae)

Egyptian Mouthbreeder—(*Haplochromis multicolor*) 62 mm.

Cutteri—(*Cichlasoma cutteri*) 90 mm.

Portalegrensis—(*Aequidens portalegrensis*) 100 mm.

*These fish are best if placed in tanks containing other fish when they are only about half grown; otherwise, some will chase smaller fish.

APPENDIX 2

Water for the Aquarium

It cannot be assumed that all water is suitable for aquaria. Quite the contrary. Most city water is treated with alum, or a similar precipitating substance, and with chlorine. Copper plumbing is treated with waterglass in hard-water regions. Hard water itself is often harmful to aquatic life. However, do not be discouraged by this factor, for water is easily made suitable.

Chlorinated and hard water can be corrected for the aquarium by boiling it. About ten minutes of hard boiling drives off the chlorine. When the water is cooled to room temperature or below, the excess salts in hard water will partially settle out and the clear water can be decanted off. Let the boiled water stand overnight in a large, rather shallow pan. It is now ready for use, except that it is probably low in oxygen content. Pouring it back and forth between two containers a time or two will remedy this deficiency.

Some water, particularly in hard or alkaline water regions, will prove to be unsuitable for an aquarium, even though fish may live in it in outdoor pools.

Where the water is in doubt or where it is known to be unsuitable, it is best to get water from some pond. A duckweed-covered pasture or woodland pond is best. Remember, a surface mat of vegetation is usually a sign that the water is good. Strain such water, put it in your tank, and watch your plants and fishes grow.

There are a few rules to remember:

1. When adding water to a tank or transferring fish to a newly established aquarium, be sure that all of the water is of the same temperature.

2. Never put more than 50 per cent new water in an aquarium containing fish.

3. Replace evaporation losses with rain water, distilled water, or soft water.

4. Periodically siphon off all sediment from the tank bottom.

5. About twice a year, say in early spring and fall, siphon off half of the water and all of the sediment possible. It often pays to remove all plants and animals before siphoning. Replace the water removed with distilled, rain, or soft water, to which one level teaspoonful of sea salt per gallon has been added. The salt replaces exhausted minerals and acts as a tonic. Sea salt, sometimes sold under the name "Turk's Island Salt," can be obtained from pet stores.

APPENDIX 3

Treatment of Diseased Fishes

Since any hope for the recovery of a diseased fish involves increasing its resistance, it should be fed suitable living food if possible. Isolation is desirable, but do not forget that the fish should not be subjected to a sudden change of temperature. Ailing native fishes should be kept at 65° F, exotic fishes at 72°-85° F, depending upon where the species came from.

TREATMENT FOR GENERAL ILLNESS

One of the most common ailments of wild fishes is a general disinclination to eat or move, frequently accompanied by an increased speed of breathing and a caved-in appearance of the belly. An addition of one teaspoonful (level) of common salt and one teaspoonful of Epsom salts to each gallon of water, followed by an abundant supply of living food, such as daphnia and small earthworms, will often work a cure. Change the water after a couple of days. If this treatment does not work, place the fish in a tall container and pour in enough table or rock salt to cover the bottom about one quarter inch deep. Watch the fish carefully. As the salt dissolves, the fish will begin to show signs of distress. If it starts to roll over on its back, put it back in fresh water; at any rate,

take it out in half an hour. Repeat this procedure daily if necessary. Goldfishes and native fishes respond well to this concentrated salt treatment, but it may prove to be too drastic for rare exotics.

FOR FUNGUS

Fungus is a slimy or hairy growth over the scales, fins, or mouth of a fish, and usually marks the site of an injury. The treatments are various. The fish may be lifted out of the water very gently and the place swabbed with 2 per cent mercurochrome, 5 per cent methylene blue, or a cherry red solution of potassium permanganate in water. Be sure not to get permanganate on the gills. Permanganate should be a last resort for exotics, for many seem to be very sensitive to it.

FOR EXTERNAL PARASITES

One of the most common animal parasites of aquarium fishes is the protozoan parasite *Ichthyophthirius multifilius,* which lives up to its long name by being a rapidly multiplying skin parasite. An infested fish will droop listlessly, and tiny, milky specks that look like sand grains can be seen covering it, especially on the fins and gills. In a few days the adult parasites drop off, each giving rise to a swarm of progeny. Each adult leaves a raw, bleeding spot on the fish. After some days of this infestation the fish dies. In the case of cold water fish, enough potassium permanganate can be added to the aquarium barely to tinge the water with pink. This treatment should be repeated about twice a week, or until all symptoms disappear.

Exotic fishes suffering from *Ichthyophthirius*, frequently called "the itch," as the fish try to scrape off the parasites, are best treated with mercurochrome or methylene blue. Three drops of 2 per cent mercurochrome per gallon of water, or two drops of 5 per cent methylene blue per gallon, will usually effect a cure. The water of the aquarium containing the infested fish is treated. At the same time the temperature is kept not lower than 75° F. After two weeks, the treated water should be replaced.

Sometimes parasitic worms will be seen on the gills and on or in the skin of fishes, especially goldfishes. If possible, pick them off

with tweezers. If it is not possible, try the concentrated salt treatment mentioned under "Treatment for General Illness," or place the fish in pale cherry red colored solution of potassium permanganate for half an hour or until the fish shows signs of distress. (Remember, do not use permanganate on exotics!) Repeat the treatment until the fish is cured. At the same time place enough permanganate in the aquarium to color the water a faint pink. Replace the water in the aquarium when a cure has been effected.

BROKEN FINS

There are several causes for broken fins. One fish will sometimes bite the fins of its fellows. While some species have this inclination, fin biting is often the work of a single individual which may be destroyed or placed in solitary confinement. A crayfish in an aquarium will often tear the fins of fishes while trying to catch them. Water that is too alkaline will cause fins to split. This factor is especially troublesome where the water comes from wells in limestone country and is hard. The only remedy is to change to pond water.

TUMORS

Tumors may occur in the skin, within the body, or in the eyes. It is best to destroy promptly fish diseased in this way.

DROPSY

Dropsy takes the form of a general bloating of the body, so that the scales stand out at an angle from the skin. It has been blamed on poor diet, including a diet consisting too exclusively of "white worms" (Enchytraeids). It may be relieved by draining off excess fluid and changing the diet, but seems to be incurable.

APPENDIX 4

Treatment of Ailing or Diseased Reptiles and Amphibians

FOR GENERAL INDISPOSITION

The most common ailment of reptiles is a general inactivity accompanied by a refusal to eat. There are two possible causes: the need

for a higher temperature, or for sun baths. Usually a reptile, whether it be snake, lizard, alligator, or turtle, suffers from a lack of both heat and sunlight.

HEAT

The temperature of native animals should be 70-80° F for most of the day and should not drop below 65° F at night. Lizards should be kept at a temperature of 80-90° F. If reptiles, particularly, are to be left over week-ends or vacations in a building with the heat turned off, it is best to move them to the boiler room. An electric bulb, preferably connected to a thermostat, or an aquarium or vivarium heater placed in the water or earth and connected with a thermostat, will also work very satisfactorily. Good thermostats and heaters can be obtained from stores selling tropical fish. If the heater is to be used dry, be sure to get a guarantee that it is suited to the purpose, for most of them are made to run immersed in water.

ULTRA-VIOLET LIGHT AND SUN BATHS

Sun baths for reptiles and amphibia are very important. Half an hour or so of direct sunlight, with no glass between sun and animal, or a few minutes under a sun lamp, will help greatly to keep these creatures in good condition. Clear cellophane or poultry "glass," such as "Vitaglass," can be used for the tops of cages, since these substances do not keep out ultra-violet light as does ordinary glass. Ultra-violet bulbs can now be purchased but should be used with discretion, for they give out not only ultra-violet light but also enough heat to burn up ordinary light fixtures and injure the patient.

FOR FUNGUS

Fungus appears chiefly in the mouths and around the eyes of reptiles and amphibia, but may appear in breaks in the skin as well. When it appears the living quarters should be thoroughly soaked in a cherry red solution of potassium permanganate, and the affected animal should be dipped in some of the solution. A cotton swab dipped in the permanganate solution may be used to wash

the diseased area further. Turtles should be allowed to swim in the permanganate for half an hour before being transferred to clean water.

Reptiles may also be allowed to swim in a salt solution containing one tablespoonful of table salt per gallon of water. After not more than one week, they should be given fresh, unsalted water.

FOR "REDLEGS" OF FROGS

"Redleg" is a bacterial disease which manifests itself as a red inflammation showing chiefly on the thin, pale skin of the underside of the hind legs and on the belly of frogs, although it may appear on other amphibia. The red appearance is caused by the rupturing of the blood capillaries. It shows most where the skin is thin and pale but affects the whole body. An infected bullfrog of ours jumped off a table and literally splashed when he landed on the floor. This condition is seldom noticed until it is too late to treat it. The disease is highly contagious and usually fatal.

When large numbers of native frogs must be stored alive I recommend that they be washed in a solution of permanganate, astringent to taste, and allowed to sit in a shallow, faintly colored solution of it for about two days thereafter. Subsequently they may be placed in a cool place, such as an old-fashioned spring house, in tubs containing a depth of about 10 mm. of pure running cold water. The tubs should have lids of muslin stretched over wooden frames. Such a lid excludes light, thereby lessening the activity of the frogs, and they cannot injure themselves on it as they do on wire screen lids.

If this disease has been introduced to storage quarters used for amphibia, the floor, nets, tanks and various utensils should be thoroughly soaked with a cherry red solution of potassium permanganate or a lye solution. The proper proportions for the solution are indicated on the can.

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